THE TETHERED SOW

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MODERN FARMING

A Practical Illustrated Guide

Edited by
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Volume Two

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EDITORIAL PREFACE

In the first volume of this work six authors dealt with certain aspects of *Modern Farming*. Their six sections, or books, began with V. C. Fishwick's masterly survey of the whole field of *Good Farming* and provided readers not only with that general background which we all like to have provided for us when we begin the study of a subject quite new to us but also gave newcomers many wise words of warning. *Good Farming* must have saved many ex-servicemen disillusionment and heavy financial loss, because in those authoritative pages is painted no glowing picture of agriculture as a ready way to make money in a pleasant post-war life of ease and plenty.

The next section was Donald V. Fletcher's *Good Farm Workmanship* which brought a breath of real country air into our work and added that practical touch and human contact with the great industry which is so important for all who live among farmers, even for those who are not themselves engaged in agriculture. The kind of knowledge imparted by *Good Farm Workmanship* will help to a better understanding of all that has to be done on the land; to the student of agriculture it will give much acceptable information. And here, again, in this section will be found a few words of caution against a too ready acceptance of the view that living in the countryside or work on a farm means all that a bright summer holiday among crops and stock sometimes makes it appear to be when town-dwellers are able to enjoy it for a fortnight, or more, in warm dry weather under cloudless skies. As a contrast, mud and cold and hardship must often be faced on a farm in the long dark hours of winter. Victor Fishwick and Donald Fletcher help us to take a more complete view of farming than is presented for us by many agricultural writers to-day.

Mechanization, crop husbandry and business methods on the farm also received authoritative treatment in Volume I.

Now, as you take Volume II into your hand, you will see how well the story is being continued by those who from expert knowledge provide us with the next six books or sections that it contains. The men who have written on these subjects: *Good and Healthy Animals*, *Good Milk Farming*, *Good Sheep Farming*, *Good Poultry Farming*, *Good Pig Farming*, all know what they are talking about, and not only will what they say be found instructive by agricultural students, but experienced farmers, as well, will agree that here, undoubtedly, is something which even they can absorb with benefit. The more we know about a topic, the more we realize there is to learn and so men who have spent all their lives on the land and seem to us to know all the answers will here find new points of view and something fresh to stimulate enquiry into the validity of their own ideas and methods.

From the student's angle little need be said here about the obvious need for expert instruction on the subjects covered in the first five sections of the present volume, those especially concerned with stock. They form the basis of a large part of the practice of farming and for those who are learning about Good Farming some such course of study is absolutely essential. It will here be found in a very attractive form.

I think those already well instructed in the mysteries of husbandry will especially find Mr. Paterson's section on *Good and Healthy Animals* somewhat absorbing. He is an expert veterinarian and we are delighted to be able to give our readers the benefit of his knowledge and advice.

Nothing helps us, perhaps, in our job more than "talking shop," and so we commend these pages with confidence to the student of this ancient craft and have pleasure in also bringing them to the notice of all whose life and work has already been long devoted to the raising of stock and the growing of crops, in making their great contribution to the food supply and health of the nation.

The last section of this volume is by H. H. Glasscock. It is one of those specialized applications of science to agriculture which have only been possible in comparatively recent years. No intelligent agriculturist to-day minimises the great importance of making the industry efficient by the application of some of those principles which biologists, geologists, chemists and physicists have now been studying with unremitting care for more than a hundred years, and so *Good Control of Plant Diseases*, which is the fruit of this kind of work in a biological field, will certainly be heartily welcomed by progressive people in the industry. Plant diseases, insect pests and many other troubles loom large to-day in the consciousness of farmer and gardener and under modern conditions nobody in agriculture can afford to be ignorant of the principles of plant protection which are known to all properly trained farmers in the competitive world of the present day.

Only a farmer who adopts adequate measures of control against mildew and blight and "fly" and "flea" can hope to raise as good a crop as his neighbour who knows all about these troubles and takes the proper steps to defeat their depredations. The insects we can leave to our third volume, but here we find the story of the fight against plant diseases unfolded with lucidity and it is no mere miserable catalogue of fungous troubles attacking crops. It is the success story of those who know the dangers and take the proper steps to defeat them. Mr. Glasscock's subject is technical and his section one which the student of *Modern Farming* will find important for his work; at the same time it is so clearly expressed that the general reader will find it very acceptable, as an account of the work the mycologist is doing to-day in the service of those who grow our food.

So we recommend this well-illustrated volume to your attention, confident that you will find the wide range of information it contains up to the high standard that is necessary for anyone so interested in *Modern Farming* that he desires to play an efficient part in the industry. Again to those who live in the country without earning their livelihood in the pursuit of agriculture we think it is true to say that we here offer a picture of farming life and practice which will enable them to take an informed and intelligent interest in the work described and perhaps in busy seasons to take some not unhelpful part in its activities.

S. GRAHAM BRADE-BIRKS.

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SECTION I

GOOD AND HEALTHY ANIMALS

by

J. D. PATERSON M.R.C.V.S.

INTRODUCTORY NOTE

BEING AN APPROACH TO THE SUBJECT

In the study of animals, their structure and the function of their organs as well as their diseases, it is necessary that there should be some understanding of the fundamental basis of living things. The various organs and components of the animal body may be examined individually. We may study the skeleton and the bones which it includes, the digestive system and its various parts, the circulation of the blood and the structures which take part in this function, and so on, but the enquiring mind is bound to ask, " Of what are these various parts of the body made and how do they arise? " Of course they are all produced within the womb of the mother before birth; but by what miraculous process is the young animal built up and finally endowed with *life?* If we could answer this query we could equally well explain the phenomenon of life but since this is beyond our knowledge we are restricted to a study of the processes and structures which are manifest in life. We know how an animal grows and takes shape in the womb because its development has been studied by scientists from the very early days. We know and understand, fairly well, the structure and functions of the various organs and tissues of the body, and as a result disease processes are more readily understood, but all this knowledge has arisen gradually from a detailed scientific study of the various parts of the body and their workings and it includes an understanding of most minute details. Therefore as an introduction to further consideration of the animal body and its diseases let us look very briefly at the minute or microscopic structure of all living matter.

All living things are composed of cells. The simplest forms of life both in the plant and animal world are made up of single cells which live a free life, and while some of them can move all can reproduce themselves and all depend on their environment for nourishment and existence. It must be understood however, that such lowly forms of life cannot control any part of their circumstances at will; they react to certain stimuli in well-defined ways it is true, but conscious effort or sensation plays no part in their living, and although alive they can see nothing, feel nothing and hear nothing as we understand those things—in short they merely exist.

But as we ascend in the scale of living things we meet with other forms of life which are composed not of single cells but of collections or aggregates of cells, some very simple aggregates, but some most complicated in their arrangement. In fact we find that in many animals certain cells or groups of cells in the individual have become very specialized and have taken upon themselves special functions. Also they are grouped together in certain very definite arrangements, and in the higher animals we find such groups composed of millions of cells and forming organs of the body. Thus, in such animals, specialized cells and their products constitute parts or organs which perform certain special and recognizable functions and no others; thus the cells which form the liver will never act other than as liver cells and so the liver has a function and structure which are determined by the actions and arrangement of the cells of which it is composed. Similarly all organs of the body have a certain definite shape, size, position and purpose and all these depend upon the arrangement and action of cells.

We have seen how the animal body and all it contains is built up of cells and cell products but so far we have not enquired into the structure of the cell itself. All living cells are composed of a substance called *proto-plasm.* This is an extremely complex chemical material, viscous in character and usually of a whitish colour. It responds in various ways to different types of stimuli, it is capable of reacting chemically with various other substances, it is capable of reproducing itself and in its proper environment it has vitality—in other words it has life.

THE OWNER AND HIS ANIMALS

Our author explains the scope of this section and gives an outline of additional matters which the owner should know to aid him in understanding disease. Health and disease are defined and the causes of the latter summarized. Symptoms and their meaning are explained and diagnostic methods described. Normal body temperatures are given and the difficulty of diagnosis of disease in animals discussed. Types of wounds, abscesses and injuries are dealt with and first aid treatment explained, including methods of stopping bleeding.

(i)

The Author's Intention and Limitations.

THIS book is intended mainly to provide a description of the more common diseases and ailments to which farm animals are subject. It is necessary however that, in order to understand many disease processes, a knowledge of the structure and function of the part attacked should be acquired. Unfortunately however in a work of this limited nature it is not possible to study systematically all parts of the body, but where it is considered to be most essential to the comprehension of a disease, the part attacked or the one involved in a particular disease will be found to be described.

Prevention Desirable; Treatment Essential.

In order to maintain animals in a good and healthy condition it may be argued that prevention of illness is of much greater importance than the recognition, treatment and control of disease. Such an assertion cannot be denied, but, until the science of veterinary preventive medicine has progressed further, recognition and early treatment of animal disease will remain of paramount importance. This being so, the earlier the condition of disease is identified and the more the owner understands about its nature, its probable outcome and possible complications, the more readily will he take measures to have the condition brought under control. In very many instances the veterinary surgeon is called in to treat and attempt to cure a dying animal or one in which disease is so far advanced that the prospect of recovery is remote.

Danger of a Little Knowledge.

It is not intended that this book should help an owner to apply remedies to cases of disease among his animals except in so far as first aid and nursing are concerned. Of course nursing is largely the application of common sense and no special section of the book is devoted to it. However, where there are special precautions that must be observed or where there are possible pitfalls, these are mentioned. In the sphere of disease treatment, as much as in any other, it can be said with absolute truth that a little knowledge is a dangerous thing. Except in some few cases wherein specific remedies can be applied to certain diseases there are no hard and fast rules about treatment of disease; in fact, some diseases occurring, say in two different herds of cattle, may require the adoption of quite different control measures depending upon the circumstances surrounding the outbreak. Moreover, and although difficult of comprehension, it is a fact that the same disease may have to be *treated* differently in individual animals or in separate herds.

Disease Prevention.

The subject of disease prevention will not be ignored however, and where its application is possible the procedure will be explained. Under this heading, also, one might well include the all important principles of general hygiene, disinfection and animal management but it has been found impossible to deal with these in a general way. However should they be particularly applicable in the case of any disease their application will be stressed.

Know Your Animals.

One other word—know your animals in health, so that any change in habit, posture, appearance or any departure from the normal can be recognized immediately and the seriousness or otherwise of the condition assessed; so that you can give your veterinary surgeon a chance—call him in early if you mean to enlist his help at all. Where animals are congregated together they are rarely all healthy at all times. Disease promptly dealt with will assist greatly in the maintenance of stock which is good and healthy.

(ii)

Health and Disease.

It has been said that disease is any departure from health and, although it is difficult to find a better definition, one is immediately tempted to ask, " What is health? " Presumably the standard of animal health will differ in different areas and different countries according to the standard of nutrition. This being so, one cannot say that health is one particular state which an animal must attain before it can be called healthy. The question must be answered by making a survey of the greatest number of individuals possible, and deciding that the condition which one finds present in most of them is a state of health.

Causes of Disease.

When considering why disease occurs in our animals, it cannot be emphasized too strongly that there is always a cause; some force or condition is at work which is affecting the animal and making it ill. In other words every state of disease has a cause, and methods of treatment

and prevention are influenced fundamentally by knowing the cause. It is possible to make a long detailed list of the probable causes but they may be given in general terms. Faulty diet may be a reason; and this, of course, includes the lack of any essential which should be in the diet or any addition to the food which may be harmful. Under this heading also we may include accidental occurrences such as poisoning, be the poison contained in plants, water or elsewhere. Another common cause of disease is injury due to hard knocks, wounds or to some other factor which may injure the body mechanically such as burning by heat, electricity or chemicals. Perhaps the commonest causes of disease, however, are other living things whether they be disease germs, worms, and other parasites or other living organisms which prey on man and his animals.

The second of these causes, wounds and injuries, will be dealt with in the present section in a general sort of way. The remainder of the book will be devoted largely to a description of a selection of the other diseases which are most commonly found in domestic animals.

(iii)

Disease symptoms are many and varied but this subject may usefully be dealt with in general terms. Many of the symptoms which one may expect to find when an animal is affected with a particular disease will be described when that disease is discussed. However, some short notes on disease symptoms in general will not be out of place.

What is a Symptom.

The word *symptom*, when applied to disease, may be described as any change indicating a departure from health that can be detected by the senses of the observer. In other words, there is something about an animal which one can see, feel or hear which is not normal. Indeed, even the sense of smell can be brought into play when making an examination since the odour of the breath, of urine or of milk may tell its own tale.

It will be appreciated, then, that one must be very familiar with animals in their normal state in order to be able to detect slight changes that may occur in their behaviour, in their habit or in their appearance and one must be alert to observe signs which may be rather obscure.

Few Symptoms are Diagnostic.

It must be understood, too, that very few diseases exhibit symptoms which point directly to the seat of the trouble, or determine without doubt the particular disease from which an animal is suffering. The principal exception to this is a disease which attacks some particular part of the body that is easy to examine, so that one can readily see or feel the effect of the disease. For instance, lameness usually means trouble in one or more limbs or in the structures immediately above them. Even in a case such as this, however, the inexperienced may have some difficulty in detecting the lame leg. On the other hand, if an extensive swelling is visible, matters are simplified considerably. Such symptoms which show us with certainty where the trouble lies, or what its nature is, are called *diagnostic*.

The diagnosis of disease would be a simple matter if all conditions of ill-health had their diagnostic symptoms. On the contrary however it is usually by consideration of a number of symptoms and by a process of eliminating the possible causes of these symptoms that one arrives at definite conclusions.

Signs of Illness.

It is rare to find only one indication that an animal is ill. Apart from minor ailments or injuries, perhaps the first thing noticed in an ailing animal is that it has not eaten all or any of its food. Usually this state of affairs is allowed to pass without undue concern if it happens only at one meal; probably the digestion is upset, one thinks. However if no food is consumed for a whole day, or if an animal just picks at its food at meal times, one naturally makes some attempt to find out why. In other words, one makes an examination for further symptoms. Of course, other signs may have been noted before, such as dullness of appearance and eye, a lack of lustre in the coat, a dropping of the head, the holding of ears in an unnatural position, constipation; all of these are among symptoms that tell us that the animal is not well, but they do not tell us why it is not well.

Body Temperature.

Perhaps the next procedure, and always a wise one, is to take the animal's temperature. This is done by inserting the bulb end of a clinical thermometer into the bowel, having first lubricated it and ascertained that it registered below the normal temperature of the species of animal concerned. The normal temperatures of the various domestic animals are: Horse 100·5° F., Cow 101·5° F., Sheep and Goat 101° F. to 104° F., Pig 101° F. to 104° F. (depending on age), Dog 100·5° F. and Fowl 107° F.

In general, the normal temperature of young animals is slightly higher than that of adults, the most marked age difference occurring in pigs. Also the normal temperatures of individuals of the same species may vary slightly and those given constitute average temperatures.

If the temperature has risen two or three degrees above normal, then fever is present. When fever is present it is almost always an indication that infection is at work somewhere in the body, that is, that disease germs are busy.

Diagnosis.

In the meantime it may have been observed say,

that the animal is breathing quickly and perhaps taking short shallow breaths, and the flanks heaving with each breath. This of course will suggest lung trouble. An examination of the lungs by listening to their sounds will reveal these to be abnormal and to the trained person the particular character of the sounds may determine that pneumonia is present, that is, the sounds heard are diagnostic of pneumonia. The disease germs are at work in the lungs.

Thus it will be seen that, by the observation of a number of symptoms, a final correct diagnosis can be made. After noting each symptom one has to find out why that symptom is present. The animal was off its food. Why? Because it had a temperature. For the same reason other signs of general illness were present. Why was the temperature raised? Presumably because some infection was present. Where was this infection at work? The type of breathing indicated the lungs. Listening to the sound of the lungs confirmed this and enabled the presence of pneumonia to be established.

What the Owner can do.

It is not suggested that the owner of the animal could make such a diagnosis with certainty for himself. although severe pneumonia is one of the most simple conditions to detect. However, pneumonia might be complicated by the presence of pleurisy or fluid in the chest cavity and in such a case it would require a trained ear to detect the difference. It *is* suggested however that the animal owner should be in constant touch with his animals and always on the look out for signs of illness. Also, it is wise to have the means to take an animal's temperature, that is, to be the possessor of a clinical thermometer and to be familiar with its use. It is most unwise to permit any disease to advance to any extent before calling in professional help. Many animals have been lost because of undue delay in the application of correct treatment—and correct treatment depends on correct diagnosis.

Psychological Factor.

It has often been supposed that the exact detection of disease in animals must be particularly difficult because animals cannot talk and explain their symptoms. To some extent there are disadvantages in this but, on the other hand, the psychological factor, so important in human medicine, has not to be taken into account in animals. Every symptom is real and can be taken as having a definite bearing on the illness.

It is not so with us humans. How often do we imagine ourselves to be worse than we really are? Do we not at times decide for ourselves what our trouble is, and then proceed to search for confirmatory symptoms only to find them? Then our pains and other troubles are recounted to our doctor and he has to be able to select the real from the imaginary!

A Hypochondriac.

Animal hypochondriacs do not exist, except perhaps in the case of our sagacious friend the dog, who is quite capable of prolonging the limp occasioned by an injured leg because of the special attention and sympathy given to the invalid! Unfortunately, however, he is apt to forget to limp when interesting matters require attention.

Signs of Pain.

It must be admitted that there is a real disadvantage in the fact that animals do not consciously indicate the seat of pain. But this can be overcome to a great extent by the fact that pressure over the painful part usually results in some response from the animal, such as a sudden start or jump. Also, certain signs which point to the presence of pain in a certain part of the body can be noticed. For example, if a horse is seen to rest a fore foot while standing, there is usually trouble in that foot. Also, kicking at the belly and continually looking round at the flanks indicate pain in that region in horses and cattle. Also, other signs of pain are found in sweating for no apparent reason combined with restlessness, sometimes amounting to frantic movements and sudden convulsions when pain is acute.

Horses usually suffer in silence, but anyone who has seen one of these animals with violent colic will realize how acute the pain must be, and yet scarcely a sound, apart from an occasional groan, escapes the afflicted beast.

Cattle may also endure considerable pain without a murmur but on occasion these animals make a tremendous fuss about it, and seem to differ individually in this respect.

Dogs on the other hand can usually be relied upon to make their misfortune know to the world, although it is sometimes difficult to judge how much of the noise is due to pain and how much to fright.

(iv)

Accidental wounds of animals occur very frequently. Sometimes they are slight and require little or no treatment while at other times very severe and deep-seated injury of body tissues occurs or bones are broken.

Effects of Wounds.

No wound or injury, in itself, would ever kill an animal unless some vital part were involved or the animal were so maimed that it could not get about to perform its natural functions. It is sometimes necessary to destroy an animal because of an injury; a horse is useful only so long as his legs and feet are in good order. Wounds commonly become complicated by the presence of disease germs which gain entry, either at the

time of the mishap or later, usually at the time of mishap. Were it not for this fact wounds would heal much more readily and quickly.

Healing a Natural Process.

It must be realized that the healing of a wound is a natural process which is not readily aided by external applications but can easily be hindered. In this respect the use of disinfectants or anti-septics is very often abused. The purpose of a disinfectant is to kill disease germs and that of an anti-septic is to prevent their multiplication. But unfortunately many preparations fail in these respects unless used at a strength which may injure flesh and other tissues, and thus delay healing. Such dressings for wounds should always be used in extremely dilute condition or they will do more harm than good. Their principal effect is to cleanse mechanically, a measure which should always be carried out at once and thoroughly, provided that there is not too much interference with normal body tissues.

Abscess.

When a wound becomes infected, that is, disease germs have gained entry into it, the process of suppuration usually follows. Then, whitish matter or pus will appear and will drain away from the wound if it is open, or if the wound is closed in, will gradually burst its way through the tissues until an opening is formed. Where there is an enclosed accumulation of pus the result is an *abscess*.

Pus and its Ways.

Pus, such as one finds in an abscess, commonly burrows its way to the surface of the body but it usually takes the line of least resistance and in a deep-seated abscess, it has been known to travel inwards and open into a body cavity, such as that in the abdomen or belly or in the chest; then, of course, serious complications follow and instead of the germs being localized or confined to one part, the whole body may be affected and blood poisoning result. Blood poisoning may also arise if particularly virulent germs are at work; they may not remain confined within a wound or abscess but may progressively invade other parts; nevertheless, such an occurrence in animals is not common.

The formation of pus in a wound or the development of an abscess is not necessarily a serious matter. Either is, in fact, evidence that one at least of the natural defence forces of the body is at work to combat the invading germs. Pus is largely composed of dead white blood corpuscles, minute cells of a certain type the purpose of which will be described later.

The Healing Process.

If a wound is infected, healing cannot commence until all germs are killed or removed or suppuration has ceased. To help in healing, pus must be allowed to drain away efficiently so that as well as the actual killing off of the microbes, a mechanical cleansing results. The wounds then commences to heal from the bottom upwards, the tissues being gradually built up until level with the skin, whereupon the skin commences to grow inwards from the circumference of the wound until healing is complete. In the case of narrow deep wounds, punctured wounds as they are called, there is a tendency for the skin and surface tissues to unite over the wound, and this prevents drainage. Such wounds suppurate readily.

Types of Wounds.

Everyone must have noticed that wounds differ in type. Some are accompanied by much bruising, some are clean cuts and some are punctures made by sharp points; some heal readily, others do not; some bleed profusely and others but little, while some are little more than skin deep, whereas others penetrate deeply. From this it will be readily understood that, since wounds differ in type, so will the treatments applied.

Be Cautious.

It is not advisable that the owner of animals should attempt to treat serious wounds unaided; many of these require stitching, some require to be enlarged by use of the knife to prevent complications, whilst others, as in cases where abscesses have formed, must be lanced to allow for drainage, to promote quicker healing than would result if an abscess were allowed to burst open unaided. There is always danger in using the knife, because some important artery, nerve or other structure might be severed unless the cutting is done by someone who knows where these structures lie.

However, there are certain first-aid measures which everyone who has to do with animals should know. It is necessary sometimes to take immediate action, principally to stop bleeding. The method of doing this will differ according to the part injured.

To Stop Bleeding; Useful Methods.

When bleeding occurs in a limb or other part that can be easily bandaged it is usually sufficient to apply a pad of cotton wool or tow over the wound and to bandage it in position fairly tightly. The pad should be boiled in water beforehand to sterilize it, if there is time, or, as an emergency measure, squeezed out in a weak warm solution of disinfectant. The bandage may be applied as tightly as is necessary to stop the bleeding, but if very tight it should be slackened off in twenty-four hours.

The Tourniquet; A Warning.

The use of a tourniquet to prevent excessive bleeding is widely known, but its application is

not without danger. A tourniquet is a piece of cloth, bandage or cord twisted tightly round the wounded limb at a point nearer to the body than the wound. This prevents passage of blood down to the wound but at the same time it cuts off the blood supply to all parts of the limb below that point. If left in position for too long a period immeasurable harm may be done, because the blood may not be able to pass again below the point of the tourniquet. This method of arresting bleeding should be used only when all others have failed, and only as a very temporary measure.

If a wound should occur in some part of the body which cannot be bandaged tightly, such as in the shoulder, neck or udder, other methods of arresting bleeding have to be used. It must be stressed however, that if a wound which may have penetrated into a body cavity occurs, it should not be interfered with in any way; instead the animal should be kept warm and quiet until prefessional help arrives.

Packing of Wounds.

When a profusely bleeding wound occurs and a pad and bandage cannot be applied, one of two things may be done. The major blood vessels which have been severed may be seized with forceps and a ligature applied to each, so that the worst of the bleeding is controlled, or the wound may be packed. The former method is not easily accomplished, but the latter is a first aid measure which owners of animals should be prepared to carry out in cases of emergency. The packing used should always be sterilized and for this purpose it is useful to have at hand some sterile surgical gauze which can be readily purchased. Strips of this should be packed into the wound fairly tightly and the free end of the first and last strips should be left protruding from the wound; moreover note should be taken of the number of strips inserted. In this way *all* the packing can readily be removed when the time comes. If possible a clean bandage should be applied over the packing.

Apart from the control of bleeding, which is often an immediate necessity, there are few cases of injury wherein the owner or attendant can do much to help. The tissues of animals show remarkable powers of healing and most minor injuries will clear up successfully with such treatment as gentle cleansing and the applications of a clean bandage.

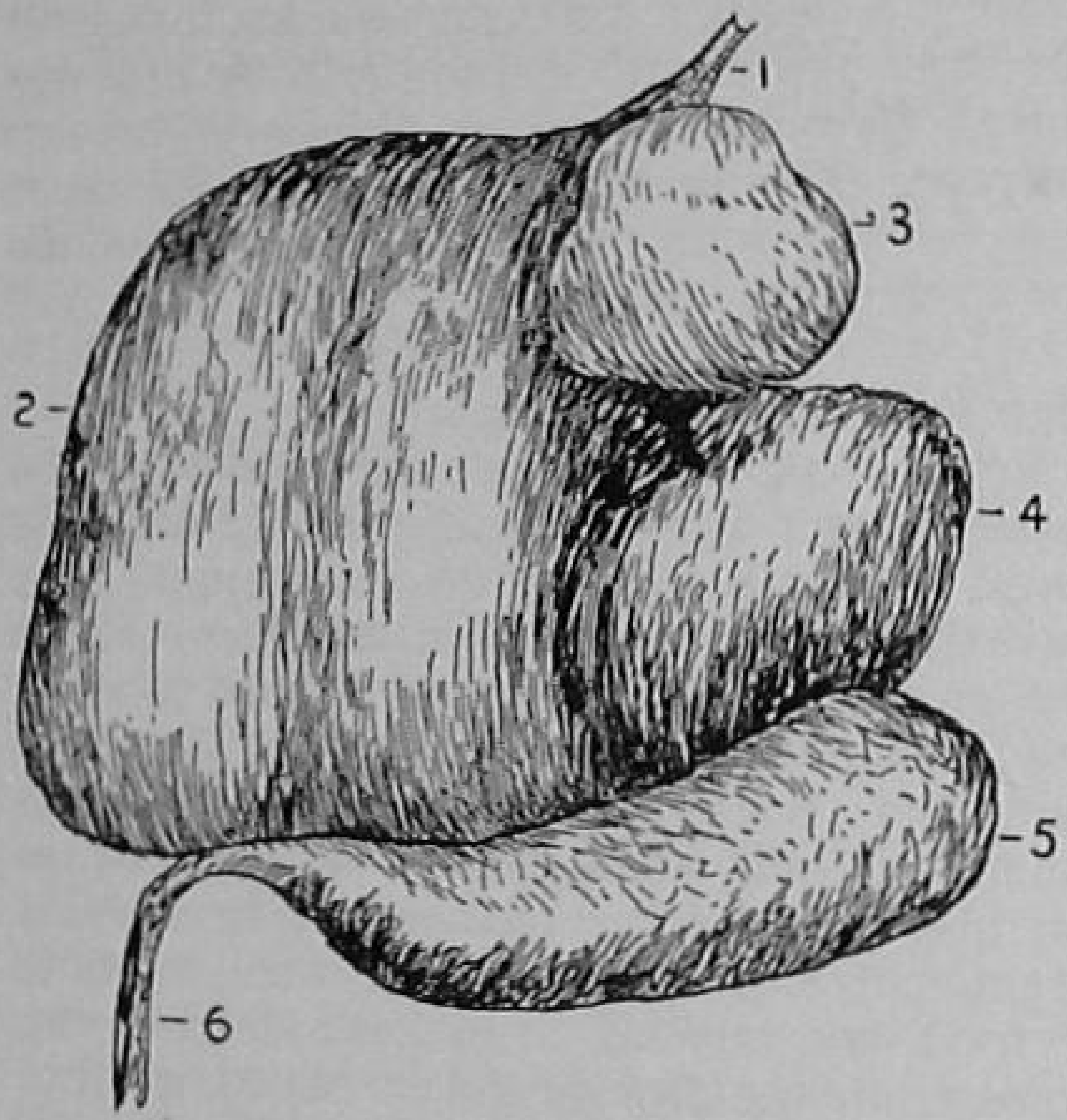
NON-CONTAGIOUS DISEASES

THE BREATHING SYSTEM AND THE DIGESTIVE SYSTEM

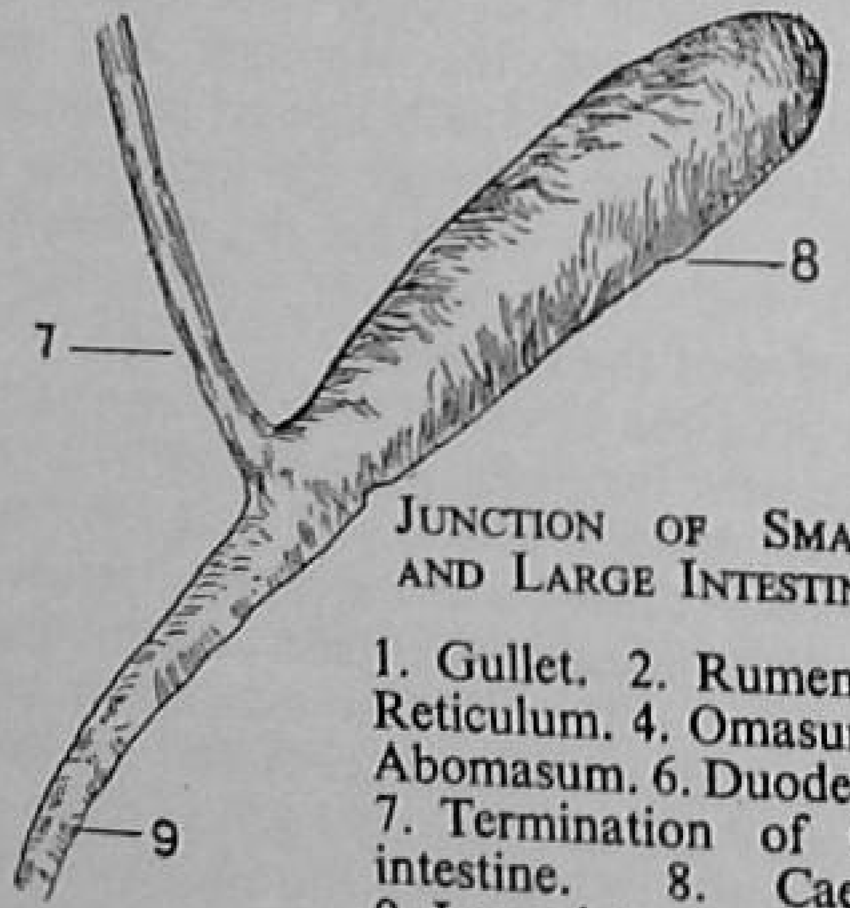
Here we learn something of the structure of the digestive organs of animals and some account is given of the process of digestion as an introduction to diseases of these parts. The breathing apparatus is similarly treated. Thus we are in a position to understand such conditions as stomach troubles in cattle, horses and other animals as well as enteritis, and peritonitis. Common conditions like laryngitis, tracheitis, bronchitis, pneumonia and pleurisy are also considered.

Non-Contagious Diseases.

THERE are certain diseases which affect the bodies of animals and humans which are not contagious. Contagious diseases and their causes are explained elsewhere, and in the meantime it is sufficient to realize that in such cases microbes are at work and that they show a disposition to spread to other animals and so transmit the disease. In certain illnesses, although the actual causes are disease germs, there is no tendency for the trouble to spread and they are therefore neither infectious nor contagious. Again, certain bodily ailments are entirely due to the fact that some mechanism or function of the body is temporarily out of order. Examples of such are to be found in many digestive disorders or again in the so-called "milk fever" of cows and other female animals. It is the present intention to describe certain of these non-infectious maladies and to give some account of the organs of the body which are involved.



STOMACHS OF A RUMINANT



JUNCTION OF SMALL AND LARGE INTESTINES

1. Gullet. 2. Rumen. 3. Reticulum. 4. Omasum. 5. Abomasum. 6. Duodenum. 7. Termination of small intestine. 8. Caecum. 9. Large intestine.

(i)

The Digestive System.

Probably the part of the body most subject to disorder is the digestive system, that is to say the various organs which are concerned with the taking up of food, its mastication, digestion and absorption into the system as well as the expulsion, from the bowel of waste matter.

The first part of the digestive system, the mouth, requires no description. The food is taken up, masticated or chewed by the teeth, then swallowed.

In the act of swallowing food passes down the gullet or oesophagus which is contained in the neck and passes through the chest cavity to the stomach.

Compound Stomachs.

In ruminants, that is animals which "chew the cud," the stomach is a compound sac and is composed of four main compartments. The first compartment, called the paunch or rumen, is extremely large in relation to the size of the animal. The second, the reticulum or honeycomb is much smaller and these two together act as reservoirs for storing food mixed with water before the act of rumination or bringing up the cud for further mastication. The third stomach, manyplies or omasum is a more complicated organ in that it contains many fleshy folds or partitions which pass from its wall into the interior of the organ. The fourth stomach, true stomach or abomasum is similar to the stomachs of non-ruminating animals and is concerned solely with digestion.

In animals apart from ruminants the stomach is composed of one compartment only. It resembles the abomasum in shape, being elongated and pear-shaped and its walls are supplied with glands which produce digestive juices which are passed into its interior.

The Intestine.

Food leaves the stomach by passing into the intestine or bowel, which is a continuous tube of

great length; it lies in intricate folds and loops within the abdomen and is anchored to the underside of the back of the animal by means of a fan-shaped membrane, the apex of the fan being attached under the spine while the intestine runs along the base. This arrangement although suspending the bowel within the abdomen allows considerable movement and shifting of position to take place.

The Duodenum.

The first part of the intestine, that is the one connecting with the stomach, is called the duodenum and the portion which connects with the outlet from the body, or anus, is known as the rectum. The anus is situated under the root of the tail and through it the residue of the food goes out of the body. As the food has passed along the whole length of the digestive tract most of the nutritious matter has been extracted from it.

As well as the names "duodenum" and "rectum," the terms "small intestine" and "large intestine" are used to describe different parts of the bowel. The former commences with the duodenum and comprises considerably more than half the complete length of the intestine. It terminates by opening into a sac-like pouch, the caecum. The large intestine continues from the caecum and ends with the rectum and anus.

The process of digestion takes place mostly in the stomach and small intestine. By digestion is meant merely the changing of certain constituents of the food into forms that can be absorbed into the walls of the intestine from which they reach the system proper. In this way the body is supplied with necessary nourishment, for it is conveyed from the intestinal walls to all parts of the body by the blood stream and other means.

Digestion.

Digestion depends upon the action of ferments produced by glands present in the wall of the stomach (abomasum in ruminants) and the intestine, with the addition of further ferments produced by an organ called the pancreas. The ferments from the pancreas are carried into the duodenum by means of a small tube or duct.

Rumination.

Before food can be digested properly it must be finely broken up, so that the digestive juices can mix with it thoroughly. An exception to this would seem to be found in the dog which can apparently bolt large meals without suffering any digestive inconvenience. The preliminary breaking up is done by the teeth and in most animals this is carried out adequately while feeding. In ruminants, however—such as cattle, sheep and goats—when the food is first taken up it is given a preliminary chewing and is then swallowed, a process aided by the lubricating action of saliva. It passes to the rumen and reticulum where it accumulates. Later, and usually when the animal is resting, rumination commences. In this process a small amount of food and water is brought back up the gullet into the mouth and is thoroughly chewed and then swallowed again; next other small amounts of food and water are brought to the mouth in succession until all has received this treatment. After thorough mastication the food passes to the third stomach or omasum where it is rubbed down to a still finer state by the fleshy leaves or partitions present in the organ. Thence the food passes to the abomasum which acts like the simple stomachs of other animals.

Water Necessary.

Water is absolutely necessary for the process of digestion and lack of it can give rise to serious digestive disorders. From the fact that the digestive juices which carry out the necessary changes in the food are fluid in nature it follows that if insufficient water be present the whole process is upset. Also, nutrient matter is for the most part absorbed into the body in a dissolved form and water is necessary for this purpose. The process of digestion will cease completely if water is withheld from an animal for a sufficient length of time.

How Food is Passed Through.

Food is passed through the whole of the digestive tract by mechanical means. Successive waves of contraction pass down its length, each wave pushing the contents a little farther towards the anus. The process can be likened to what would happen if a rubber tube were filled with paste and then drawn between the finger and thumb. If only slight pressure were placed on the tube, and the action repeated, the tube would be gradually emptied. In this way small amounts of food are expelled in succession from the stomach into the intestine and are passed onwards and eventually leave the body at the anus.

Derangement of the digestive system in our domestic animals is a not uncommon occurrence. It can be slight in effect or so severe as to involve inflammation of the stomach and intestines. Slight upsets are usually caused by errors in diet, a circumstance which is all the more likely to occur in animals which are fed artificially.

Impaction of the Rumen.

On occasion in cattle, and sometimes in sheep, the rumen becomes choked with a mass of doughy, comparatively dry food material; rumination ceases and the animal refuses to eat and is disinclined to take water and this aggravates the trouble. Until the animal again begins to chew its cud there is no relief and the condition sometimes persists for days and is often difficult to overcome. However, in most cases, recovery does occur with appropriate treatment and as a

last resort a surgical operation can be carried out. The rumen is opened by means of cutting through the body wall and the contents are then removed. An amazing amount of material is often taken out. Such a condition is known as impaction of the rumen.

Hoven or Blown.

The rumen of cattle and sheep may become immensely expanded with gas and then a very considerable pressure is developed within the organ. This may prove fatal if unrelieved. Certain animals may suffer from this condition periodically and at other times a number of animals in a herd or flock may be affected. In some quite serious outbreaks that have occurred in dairy herds all efforts to determine the cause have been futile. However, most cases of hoven or blown, as it is called, are caused by errors in diet and a well-known method of producing the condition in cattle is to allow them unlimited access to clover which is still wet with dew. In mild cases, correct medicinal treatment will have the desired result but in severe cases when the animal's life is in danger, the pressure must be released by puncturing the rumen through the body wall to permit the gas to escape. A special instrument is used for this purpose.

Horses may suffer from similar stomach conditions as those already described as affecting cattle and sheep. In these animals however, whether stomach distention is due to accumulated food-stuffs or to gas, the resulting condition is of a serious nature and professional help should always be sent for immediately. The affected horse may suffer intense pain and this illness may be confused with colic.

Wire in the Stomach.

A serious and usually fatal condition affecting the rumen and reticulum of cattle is the presence of some sharp foreign body which has been swallowed, usually while grazing. A piece of wire, a nail or any other similar material can cause the condition and in the south of England, during and after the flying bomb attacks of World War II, the disease was very prevalent. On many occasions cattle picked up portions of wire which had been cast far and wide by the explosion of these missiles. The symptoms of this condition are not very definite. The animal at first refuses food intermittently; on occasion grunting can be heard, rumination may cease for periods and constipation is usually present but sometimes with short spells of diarrhoea. The foreign body in the rumen penetrates forward into the reticulum and from there it passes through the diaphragm or midriff and eventually reaches the heart, causing death of the animal.

Cure Possible.

Attempt at removal of the foreign body by surgical operation may be successful and many are of the opinion that if the animal be maintained in such a position that the fore legs are on a higher level than the hind legs, much benefit or even cure can be obtained. In this method of treatment, when successful, the question will always arise as to whether the diagnosis was correct in the first place.

Gastritis.

The abomasum of ruminants and the single stomach of other animals are subject to inflammation of the internal lining, a condition to which the term gastritis is applied. Various circumstances can cause this; it may be due to irritant foods, to poisoning by irritant poisons, to infestation with parasites, such as parasitic worms, or the condition may be part of disease affecting the body as a whole. In each case the treatment will depend upon the cause of the trouble and it cannot be carried out until this has been ascertained.

Enteritis and Peritonitis.

Digestive disorder of the intestine is also a common complaint affecting domestic animals. There may be a temporary stoppage of the action of the intestine and the severity of illness which results can vary from constipation to acute colic. Common constipation usually responds to treatment with laxatives but when there is an accumulation of stagnant, comparatively dry matter in the intestine, or when there has been excessive production of gas, the condition is often serious in horses and sometimes in cattle. Again, as with the stomach, the internal lining of the intestine can be inflamed, a condition which is known as enteritis or inflammation of the bowels. The causes are similar to those mentioned in the case of gastritis and there are certain germs which especially attack the intestine, and these usually cause a very severe form of enteritis. In such cases it is not uncommon for the germs to penetrate the wall of the intestine and attack its external covering, the peritoneum. When this happens and inflammation of the peritoneum results, we have peritonitis. However, peritonitis can be present without the interior of the intestine being involved and in such cases it has usually resulted from the extension of disease from some other part of the body.

Treatment Difficult.

Enteritis and peritonitis are difficult to treat and very often, when recovery takes place, it is due as much to the animal's natural powers of resistance, and to nursing as to any drugs that have been given. Recently however certain drugs which have made their appearance are far in advance of anything previously discovered, as far as their effects upon some forms of enteritis and peritonitis are concerned. Both conditions can be very painful and diarrhoea is an almost constant symptom of enteritis, although all cases of scouring in animals do not necessarily mean

that inflammation of the bowels is present.

Young pigs seem to be particularly susceptible to bowel trouble and in very many cases the cause cannot be determined. It is probable that errors in diet or management or both are contributory factors in most cases.

Colic.

Colic has already been mentioned as the outcome of temporary stoppage of bowel action and in such cases there is almost always an accumulation of dry matter with a more or less severe accumulation of gas, both of which are temporarily retained and do not pass on through the bowel in the normal manner. Horses are so commonly affected with colic that the name is usually associated with them, but cattle can be affected and the disease is not unknown in other animals. However, colic in horses is so severe and so urgent in the necessity for its being relieved that it merits separate description.

The digestive organs of the horse are so arranged that this animal is particularly susceptible to indigestion, whether slight or severe. The stomach is small and this necessitates frequent feeding of small amounts rather than giving large feeds less frequently. Once anything has been swallowed by the horse he cannot bring it back again; horses cannot vomit. Therefore any objectionable matter must pass on through the intestine. The intestine is disposed in many curves and folds and obstruction in one of the bends can take place very readily.

Causes of Colic.

The causes of colic are usually improper foods or faulty methods of feeding. Thus overloading the stomach, the feeding of sloppy foods or foods containing too much indigestible fibre, sudden change of diet, bad teeth resulting in improper mastication, or even allowing too much water to drink while the animal is warm after exercise can cause colic. Also, horses can be attacked by parasite worms which damage the wall of the intestine, directly or indirectly, and make it very susceptible to upset. Again, the horse's intestine would seem to be particularly susceptible to irritation in any form.

Pain ! ! ! Symptoms of Colic.

Other animals are rarely assailed with such pain as that suffered by the horse in acute colic. There are different varieties of the condition which it is not possible to describe here but all are painful to different extents. In some cases the pain comes in spasms while in others it is constant. Sometimes it is very acute; in other cases it is dull and may last for days if unrelieved. In all cases the symptoms exhibited are those of pain in the abdomen but they vary with the severity of the pain. In almost all cases the animal refuses to eat and constipation is present. In less severe attacks there may be occasional kicking at the belly or looking round at the sides with general restlessness and little else is to be seen. Where pain is acute, however, the animal's movements are often frantic in an attempt to find a position which might ease the pain. He continually changes his position may throw himself on to his side, roll on his back, lie flat on his belly with hind legs pushed out behind or he may even sit up like a dog. It is dangerous to be in a loose box with a horse with violent colic. Severe sweating over the body is almost always present. As already indicated the pain is caused by the fact that part of the bowel is overloaded and swollen with food or gas.

A Dangerous Condition.

If a horse with acute colic remains unrelieved, it will die. Also, less severe cases may become acute at any time and although there is always the possibility of the attack passing off without treatment, there is always a great risk in allowing colic to persist in horses without any effort to overcome it. Colic is one of the diseases which the veterinary surgeon attends to without delay, for delay may be fatal; when a case of colic is notified it must be something of a very serious nature that is not dropped to attend to it. Until his arrival the horse should be walked about gently and never left.

(ii)

Breathing.

By the respiratory system we mean those parts of the body which are involved in the act of breathing. Animals and man must breathe to live and the essential part of air is the oxygen which it contains. Oxygen is necessary to life and it is supplied to the body by means of the breathing apparatus, that is the respiratory system.

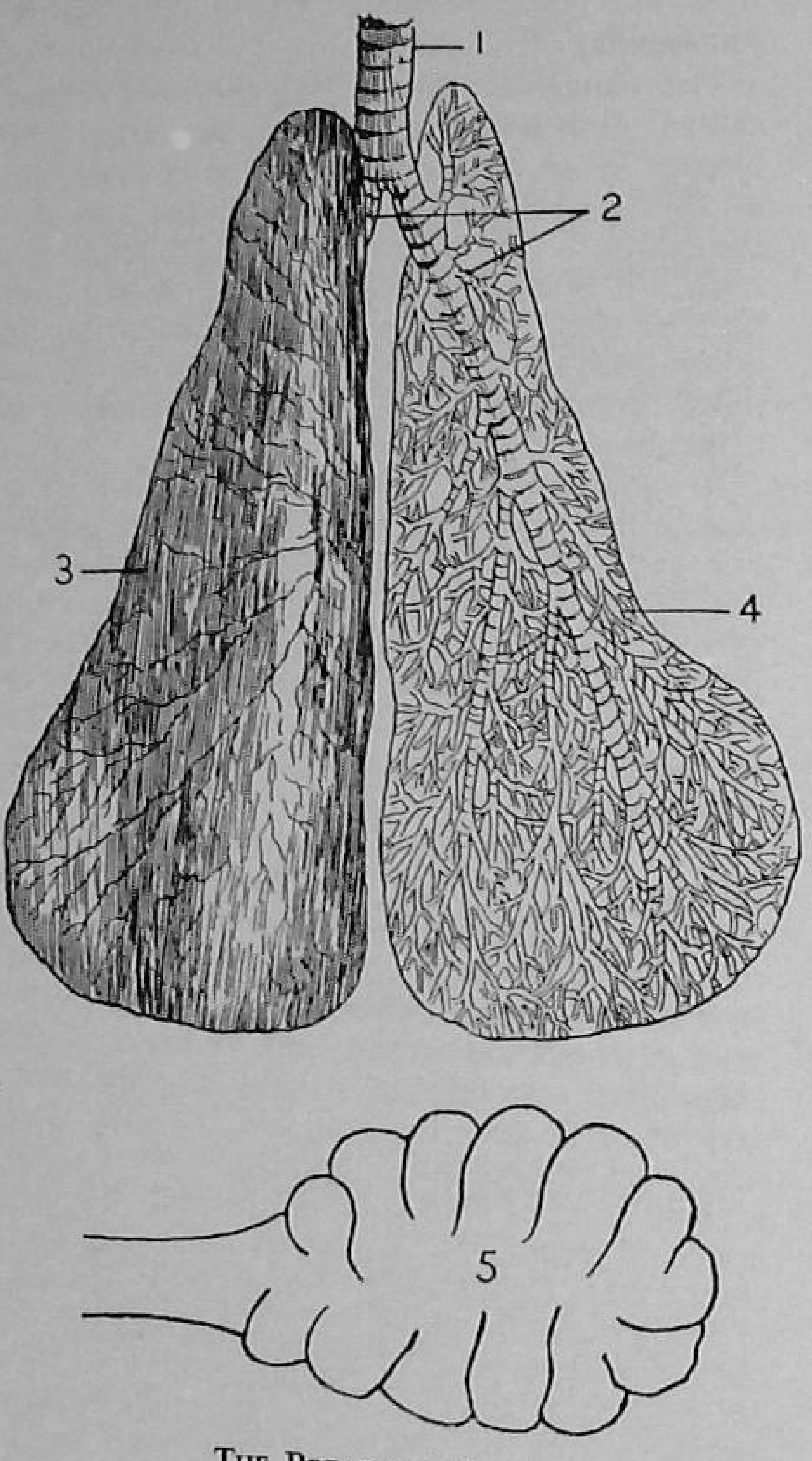
The Inviolable Route to the Lungs.

It is hardly necessary to state that air enters and leaves the body by the nostrils or mouth but neither of these parts constitutes the true beginning of the respiratory system. At the top of the neck is situated the larynx or voice box composed of a tough fairly hard yet resilient material called cartilage. Through the larynx the air passes on its way to and from the lungs. The larynx is fitted with a sort of lid which can be closed at will and is always closed in the act of swallowing so that food passes down the gullet to the stomach and not into the larynx. We are all familiar with the violent reaction which takes place when a morsel of food "goes down the wrong way." A severe involuntary coughing fit results and persists until the offending morsel is expelled. This is a defensive reaction which prevents the entry of solid material into the wind pipe. At times it may not be successful.

Larynx, Trachea and Bronchi.

From the larynx, the trachea or wind pipe

passes down the neck to the chest. The trachea is a stout tube and round it at frequent intervals are rings of cartilage which are very firm and serve to keep the tube wide open at all times. At the entrance to the chest the trachea forms two branches, the main bronchi, each bronchus going to a lung. Inside each lung the bronchus gives off numerous branches of smaller size and these are subdivided by further branching until the smallest branches of all, the bronchioles are reached. The whole arrangement is like the branches of a tree which become smaller and smaller as they branch until the tiniest twigs are reached. The trachea and main bronchi are outside the lungs, but the remainder of the branching takes place within the lungs. Each bronchiole, and there are very many of them, terminates in a blind end which is expanded to form a small space. These tiny spaces have extremely thin walls and in the walls minute blood vessels are present.



THE BREATHING SYSTEM

1. Trachea. 2. Bronchi. 3. Normal lung. 4. Representation of branching of air tubes throughout lung. 5. Method of termination of each small air tube forming an air space.

Lung Structure.

The lungs are two in number and lie one on each side of the chest, the heart being between them. They are always in close contact with the chest wall and they are covered, and the chest wall is lined with a smooth moist membrane, the pleura. In the act of breathing the lungs rub on the chest wall but because of the smooth lubricated surface of the pleura practically no friction results. The lungs are soft and spongy and are partly composed of the bronchi, bronchioles and blood vessels but principally of the tiny spaces at the ends of the bronchioles already described. The whole is supported and kept in position by a framework of strong tissue. The arrangement could be well described as resembling a sponge the surface of which had been entirely sealed over so that all the spaces were enclosed, the only way out from each being through the bronchioles, bronchi, trachea and larynx.

The whole system, from the larynx right down to the small spaces, is lined with a velvety layer and indeed this applies to all body channels and spaces which communicate with the exterior, including the digestive system. Such a lining is called a mucous membrane and it differs from skin very considerably; one has only to compare the lining of the interior of the mouth with skin to realize this.

Now, what is the mechanism by which air is drawn into and expelled from the lungs? As everyone knows under ordinary circumstances nature will not permit the formation of a vacuum. If a bellows is expanded air immediately rushes in and a concertina is played by the inlet and outrush of air which follow upon expansion and contraction of the instrument. The lungs act in precisely the same way, except that it is the whole chest cavity which expands and contracts. Air rushes into the lungs which are thus literally blown up so as to occupy the increased space following chest expansion—and so we breathe in. When the chest contracts again air is forced out from the lungs and they collapse.

The Breathing Mechanism.

The expansion and contraction of the chest is effected principally by the action of the diaphragm or midriff. This is a very strong muscular sheet which stretches transversely across the body completely cutting off and separating the chest from the abdomen. It is dome-shaped, the dome extending forward, in animals, into the chest. Now, when the diaphragm contracts the dome disappears; it is withdrawn from the chest cavity and becomes flat. This results in an increased space in the chest and so the lungs fill with air and atmospheric pressure forces them to expand and occupy the extra space. In breathing out, the diaphragm

relaxes, assumes it original dome-like shape, the space within the chest becomes smaller and so the lungs collapse and air is forced out. This action is helped by the fact that the lungs contain a considerable amount of elastic tissue which aids their collapse. Nevertheless they are never completely emptied of air.

Broken Wind.

Disease can attack any part of the respiratory system and almost always it is the result of the action of disease germs. Possibly the one outstanding ailment of domestic animals wherein the breathing apparatus is involved without germ infection is broken wind in horses. Here, as a result of debility, possibly following other disease, and overwork, parts of the lungs lose their elasticity and power of contraction. Also, some of the thin partitions between the lung spaces become broken down so that a number of spaces join together to produce cavities. Horses so affected exhibit a peculiar double effort when breathing out and the condition is considered as an unsoundness in these animals.

Carelessness.

However, in almost all cases of respiratory disease the mucous membrane is attacked by microbes, giving rise to inflammation. Microbes, or bacteria, are always present in all parts of the respiratory system and these, for the most part, are of a harmless type. There are some however, although normally not dangerous, which may become the producers of disease if the animal's resistance is lowered, say by chill, under feeding, bad management, infestation by parasitic worms or other disease. Thus, in most cases of respiratory disease, the bacteria causing the trouble were there beforehand. A not uncommon cause of the inadvertent production of lung disease in domestic animals is the careless administration of liquid medicine so that some of it has gone down the windpipe and has reached the lungs. The consequent irritation of the drug gives the bacteria their opportunity and pneumonia results. Such cases are called inhalation pneumonia. Similar trouble is often found after sheep have been dipped because some of the dip has been inhaled. Inhalation pneumonia is usually fatal.

Effects of Infection.

There is little difference in the actual effects of bacterial invasion of the lining of different parts of the respiratory system. Inflammation is set up, the lining may produce a considerable discharge, pus is usually formed and parts of the lining may be cast off. The term laryngitis is applied when the larynx is affected, tracheitis when the trachea is attacked, bronchitis when there is disease of the bronchi and bronchioles and pneumonia when the lungs themselves suffer. The last is by far the most serious condition.

The discharge which is set up and the formation of pus have the effect of impeding the passage of air. Laryngitis and tracheitis are not so serious in this respect because clearance can be effected to a considerable extent by coughing and because comparatively wide tubes are involved. However, in bronchitis, particularly where the disease extends down to a considerable number of the smaller bronchi, breathing may be very difficult and noisy and coughing very frequent.

Pneumonia.

The danger is always that the disease may extend downwards and ultimately affect the lungs. When this happens one never finds that all the bronchioles have been affected and that the disease is transmitted to all parts of the lungs; instead it is usual to find the lungs spotted with little patches of pneumonia, each patch having arisen from extension of the disease from one or more bronchioles. This type of pneumonia is called broncho-pneumonia.

In lobar pneumonia on the other hand the disease has usually been conveyed to the lungs, not progressively along the respiratory system but by the blood stream or it may be the result of the activity of germs which were already in the lungs. Consequently comparatively large areas of one or both lungs can be affected. The term double pneumonia merely means pneumonia of both lungs.

Pleurisy.

When disease is present in the outer covering of the lungs and in the lining of the chest wall, that is, in the pleura, pleurisy results. This normally smooth membrane becomes inflamed and roughened and considerable painful friction may take place between the lung and the chest wall in the act of breathing. Sometimes there is an accumulation of fluid collected between the two layers of pleura, that is, between the lung and chest wall. This, if allowed to go on increasing in amount may eventually prevent expansion of the lung and put it out of action; but the fluid can be removed by drawing it off—not a procedure for the owner of course. Veterinary help is needed.

Effects of Pneumonia.

The effects of pneumonia on the lungs are that the little spaces become filled with discharge and pus and the affected parts are put out of action and become solidified. It can be readily understood that if a sufficient area of the lungs is involved the animal will die of asphyxia, that is, lack of air. Of course one has always to remember that, apart from the actual effect upon the lungs of the bacteria themselves, there are the general effects which bacteria so often produce—fever, loss of appetite and the injurious effects of poisons or toxins produced by the

bacteria. Moreover in some instances the germs may invade other parts of the body from the lungs.

Importance of Nursing.

Respiratory disease is one of the most simple to diagnose because of the distressed and noisy breathing. However, it is not always easy to determine the extent of the condition or the particular parts involved. Pneumonia is one of the diseases, which, in many cases, has showed spectacular response to certain drugs which are of comparatively recent discovery. Nevertheless, there are no conditions which require more careful nursing and constant attention than respiratory disease, particularly pneumonia. Absolute rest, warmth, plenty of fresh air and appetizing but dustless foods are necessary and the period of convalescence should be more than adequate.

NON-CONTAGIOUS DISEASES (Continued)

The Processes of Urination and of Reproduction

Here is a matter of importance for owners of dairy herds. An explanation of how body waste is got rid of by the kidneys is given and diseases of the urinary apparatus are discussed. More important however is the reproductive system, the wonderful workings of which are described. Then some all-important diseases which interfere with reproduction are dealt with particularly those which are generally included when one speaks of "sterility" in dairy cattle. A brighter note emerges towards the end when one realizes that the commonest of all causes of sterility responds most readily to treatment.

(i)

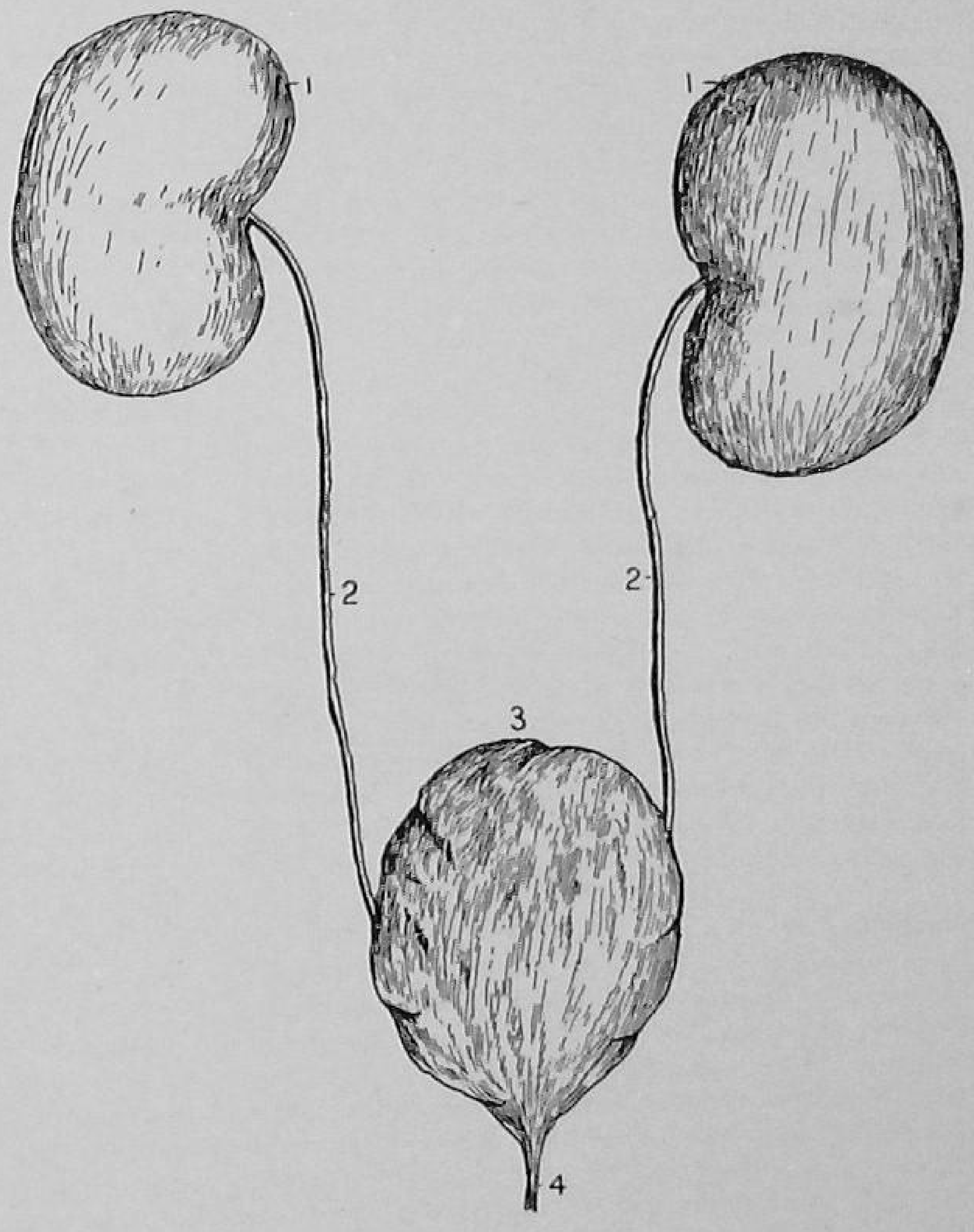
Body Waste.

The urinary system comprises those organs which are concerned with the formation of urine and its passage from the body. It has been explained how waste material is passed out from the bowel but this, for the most part, has never been in the system proper because it has merely passed right through a continuous channel in the body. Urine is another method by which body waste is eliminated but in this case the waste matter is the residue of material which has actually been in and has been utilized by the system.

The organs which produce urine are the kidneys, two in number, and they lie just under the back in the region of the loins and one on each side of the spine. They are extremely complicated organs of delicate structure and their sole purpose is the excretion of water and waste products from the blood. Life is possible with only one kidney but an animal will surely die if both kidneys are destroyed or removed.

Structure of Kidneys.

The substance of the kidneys consists of an arrangement of tiny tubes all of which commence as a blind end. This end is considerably enlarged and formed of a very thin membrane. The arrangement of this blind end resembles that of a rubber ball which has been pushed in on one side until the opposite walls are almost in contact, thus forming a hemispherical cavity. In the cavities so formed are twisted tufts and meshes of tiny blood vessels, blood being supplied to all of them by means of an artery which enters each kidney and breaks up into numerous distributaries. The structures which are formed by the enlarged and pushed-in ends of the tubes, along with the clusters of blood vessels, are called glomeruli. The tubes, many thousands of them, then pass away from the glomeruli and pursue a very twisted and contorted course, eventually straightening out and then forming large loops. After this, numbers of the tubes join together to form larger tubes, which in their turn join together and so on until the outlet from the kidney is reached. Parts of the tubes are lined with special cells, the purpose of which we shall learn later. The whole substance of the kidney is supported and fixed in position by a network of fine but strong tissue.



The Urinary System

1, 1. Kidneys. 2, 2. Ureters.
3. Bladder. 4. Urethra.

Production of Urine.

Urine is extracted from the blood in the

following manner, but it must not be supposed that urine is present in blood as such. Different materials are passed from the blood into the kidney tubes and these, when mixed together, form urine. The tiny blood vessels in the glomeruli contain blood which is held under considerable pressure. Water and other materials, which are capable of being filtered, pass out through the walls of the blood vessels which are extremely thin, and filter through the walls of the expanded ends of the kidney tubes which partially surround the blood vessels, and thus reach the insides of the tubes. In the kidneys however still another method of cleansing and purifying blood operates. The cells which line certain parts of the tubes have the faculty of extracting some waste substances from blood and passing them inwards into the interior of the kidney tubes. Blood vessels mingle intimately with these cells. By these two methods waste material is taken from the blood and eventually passed from the body in the urine.

Expulsion of Urine.

Urine is collected from the kidneys by two channels or tubes, the ureters, one of which runs from each kidney to the bladder which is situated fairly far back in the animal body and lies under the rectum. The bladder is composed mainly of muscle, is pear-shaped, and is capable of tremendous expansion. Urine collects here and accumulates until it is expelled from the body through the urethra. The urethra runs from the neck of the bladder through the penis in the male and into the vagina in the female. The vagina is the female passage which has its exit below the anus.

Nephritis.

In animals the kidneys are fairly frequently the seat of disease. Inflammation set up in the kidney substance is known as nephritis. The cause is always something which irritates. Thus, irritating chemicals or poisons which have been consumed may be passed from the body through the kidneys and set up inflammation there. Again, bacteria at work in some other part of the body may produce toxins which in passing out of the body in the urine damage the kidneys on the way. Also, bacteria may attack the kidneys themselves and do much damage, even causing suppuration; such an attack is often brought on by chill.

Types of Nephritis.

There are different types of nephritis and it is very rare to find the whole structure of the kidney involved. Were this not so and if both kidneys were equally attacked, death from kidney disease would be much more frequent than it is. The waste material steadily accumulating in the blood and body would result in very severe illness and death. This can and does happen, of course, when a sufficient amount of kidney substance is put out of action. However, the trouble may be restricted to a number of glomeruli or it may affect the cells lining the tubes; it can be either very acute and painful, or chronic and slow working so that the kidney substance is slowly and progressively destroyed. Not uncommonly cattle, particularly dairy cows, have to be slaughtered because of their hopeless condition when they have nephritis. In many of these cases the trouble is caused by a particular germ which attacks the kidneys and shows some tendency to spread from cow to cow.

Stone in the Kidney.

Horses, and cattle also, can be affected with stone in a kidney. This arises from deposits which have separated out from urine and which accumulate, eventually forming a stone-like body which remains in the kidney. Its presence is often unsuspected and it is found on examination after death. It does not necessarily kill the animal however.

Identification and Cure of Nephritis.

Kidney disease is usually accompanied by some degree of pain which may be very severe in acute cases. In fact it has been mistaken for colic. The diagnosis of kidney trouble in animals is not always easy, but urine tests often give information which points to the seat of the disease. It is unlikely that the animal owner would ever be able to determine the presence of this disease for himself. Treatment of some forms of nephritis is quite successful but in others it is most difficult to effect a cure. In some cases the damaged kidney substance remains permanently out of action, but if the disease has not been too extensive the animal will probably regain normal health.

Cystitis.

The ureters, bladder and urethra are all subject to inflammation of the mucous membrane which lines them. When the bladder is affected the term cystitis is used and, taking the domestic animals as a whole, this is probably the commonest affection of the urinary system. The bladder lining becomes inflamed and parts of it may be cast off and pus be formed. Consequently the urine may be grossly altered in character and the animal may be in considerable pain. The causes of cystitis are similar to those of nephritis but the former is a less serious condition and commonly clears up satisfactorily.

Of course it is possible for nephritis and cystitis to be present at the same time.

(ii)

The reproductive system or genital system is linked with the urinary system in that, in both sexes, their outlets from the body are in close association. For this reason they are commonly

described together in text books, but their functions are entirely different.

Reproduction and the Genital System.

The genital system includes those organs which have to do with reproduction of the species and, in the animal world, although the male is indispensable for this purpose, much more consideration is given to the female in this respect. The reproductive work of the male on the one hand is only to initiate the whole process of producing young whereas the business of bearing and rearing the young is entirely the responsibility of the female. This being so, only a very brief description of the male sex organs need be given, whereas those of the female will be dealt with in some detail. A further reason for this is that the genital system of the female is much more subject to disease than that of the male, a fact that is probably due to the effect of the repeated hazards of giving birth to young.

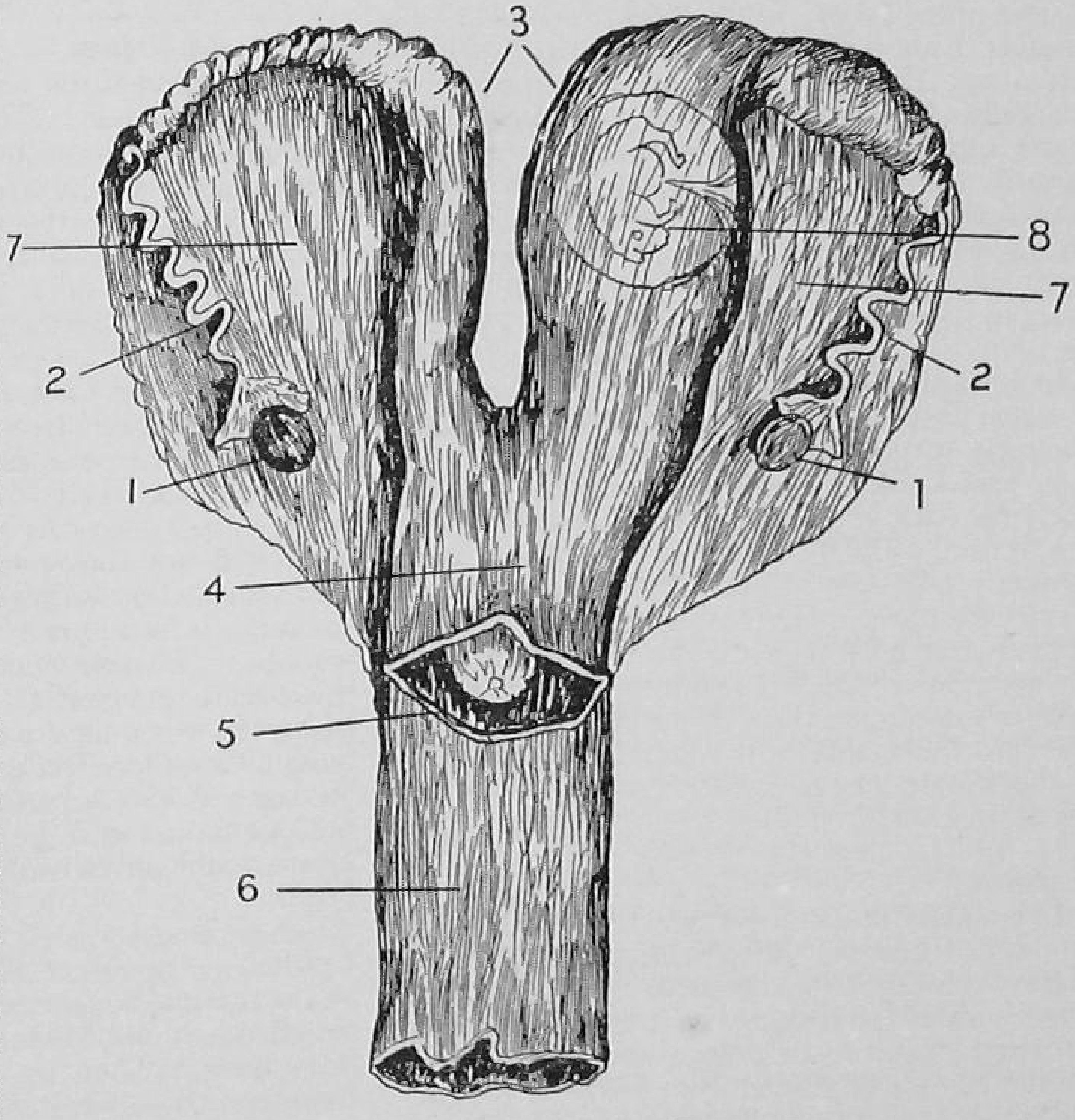
Male Sex Organs.

The principal sex glands of the male are the testicles. These produce tiny cells with tails, like microscopic tadpoles, and they can move about. These cells are called spermatozoa, or more simply, sperms. They pass from the testicles when required, along a channel which opens into the urethra. Certain glands connected with the male reproductive system add fluid to the sperms and the finished product, fluid plus sperms, is called semen. Semen passes from the body of the male through the penis during the act of reproduction (or copulation as it is called) and is deposited within the vagina of the female. To make this possible the penis of the male becomes enlarged and elongated, that is, it attains a state of erection just before the act. Spermatozoa are the reproductive cells of the male and millions are deposited within the female in one act of copulation. A single one of these, when united with a single female reproductive cell (called the egg, or ovum) fertilizes the ovum and the development of the young is ready to commence.

The sex organs of all female animals act in exactly the same way; there may be differences in relative size, and even shape, between the species but they are sufficiently similar to permit a description of one to give an adequate idea of all. The reproductive organs of the cow will be described for this purpose.

The Female Reproduction Organs.

The female reproductive cells, or ova, are present, deeply embedded in the ovaries which are two rounded solid bodies situated, one on either side, just under the spine and some way behind the kidneys. Closely applied to each ovary there is a funnel-shaped expanded opening of a very narrow but long tube which passes to the womb or uterus. These tubes are called the fallopian tubes. The uterus is Y shaped, the two arms of the Y forming the so-called horns of the uterus and the rest being known as the body. Ovaries, fallopian tubes and uterus are all suspended from above by ligaments. One



UTERUS OF COW IN EARLY PREGNANCY

1, 1. Ovaries. 2, 2. Fallopian tubes. 3. Horns of uterus. 4. Body of uterus. 5. Vagina cut open to show os of uterus. 6. Vagina. 7, 7. Supporting ligaments. 8. Representation of foetus in pregnant horn.

fallopian tube enters each horn of the uterus at its free end, which is the one lying towards the head of the animal. At the other end of the uterus the body of the uterus is normally tightly closed by a ring of strong muscle forming the os or mouth of the womb. The whole uterus in a young adult animal is little bigger than a man's hand but after a few calves have been borne it is somewhat larger. From the os a wide passage, four to six inches wide in the cow, leads to the exterior. This is the vagina and it has its exit from the body in a slit-like opening, the vulva, lying just under the anus. The whole length of the reproductive organs is lined with mucous membrane.

It has been stated that the female reproductive cells, the ova, are embedded in the ovaries. Unlike the male, where large numbers of new sperms are constantly being produced, in the female there are a certain number of ova and no more. There are very many of course, but all were formed when the ovary itself was growing, that is, when the young animal was being developed in its mother's womb. Thus, one generation is no sooner started than provision is made for the next.

" Heat " in Animals.

Most of the ova or eggs in the ovaries are in an immature state. They gradually approach the surface of the ovary, one or a few at a time, and while doing this they undergo a process of ripening, that is, they become mature. The number which comes to the surface at any one time in one or both ovaries depends on the species of animal and the number of young born at a birth. As a rule, in cows only one ovum comes to the surface of the ovary at a time, but two or even three may appear; this explains why, in these animals, twins are fairly common and triplets not unknown, although rare. The ripe ovum appears on the surface of an ovary contained in a little sac of fluid forming a blister on the surface of the ovary. This happens when the animal is in season or on heat, or " bulling " as it is commonly called on dairy farms. Female animals come in season at definite intervals (in cows approximately every three weeks) if the animal is neither pregnant nor has recently calved. At this time one or more ripe ova make their appearance on the surface of an ovary or ovaries.

Ovulation.

During the short period of heat, sometimes lasting only a few hours particularly in winter, the little blister on the surface of the ovary bursts, releasing the ovum. The ovum then enters the funnel-shaped end of a fallopian tube and is passed down the tube towards the womb. This process of shedding the ovum from the ovary is called ovulation. At this time also, that is during the period of heat, the animal shows a desire for the bull, and at this time only, and a discharge comes from the vulva.

Fertilization.

In the meantime, if the cow has been served by a bull or " bulled," large numbers of sperms will have been implanted in the vagina and these, being capable of movement, commence to swim through the os of the womb. The os is slightly open at this time and some sperms reach the womb and pass up the horns into the fallopian tubes. It is usually in a fallopian tube that contact between an ovum and a sperm takes place but it can happen in the womb itself. The first sperm that reaches the ovum penetrates it, loses its tail and the two cells, the sperm and the ovum, fuse to form one united cell, the fertilized ovum.

An ovum will not develop into a young animal unless it is fertilized and only one of the many sperms is required to carry this out.

Development of the Calf.

The fertilized ovum is now passed down the fallopian tube to a horn of the womb where it proceeds to embed itself in the mucous membrane. Here it receives the necessary nourishment for further development. The single cell which is the fertilized ovum divides into two, the two into four, four into eight and so on eventually producing cells in countless numbers. These cells so develop and grow as they divide that they produce different classes of cells each class forming the foundation of and develop into some particular body structure. Thus, certain cells will develop into bone, others into muscle, others into nerves and so on. In this way lungs, digestive organs, blood vessels and all organs and tissues of the body are gradually built up.

Mechanism of Heredity.

It should be noted that every single cell in the body has descended directly from the fertilized ovum which, by the union of two cells derived from the male and female respectively carries all characters which are inherited from the parents. So the young animal is built up and is fully formed while still very small. The greater part of the life of the developing young within the womb is occupied with growth of an already perfectly formed animal. Of course, certain structures such as hair and teeth develop later.

Although the fertilized ovum finds nourishment by embedding itself in the mucous membrane of the uterus this device does not persist and a much more complicated arrangement takes its place as the young animal grows. A calf becomes larger and occupies a greater part of the womb. It extends into the body of that organ and the womb itself increases in size tremendously as the calf grows. The calf still obtains all that is necessary for life from the wall of the womb but long before this it has ceased to be in direct contact with the wall and is suspended

in a bag of fluid, its nourishment being obtained by the means about to be described.

Nourishment of the Unborn Calf.

All who have been present at the birth of a young animal, such as a calf, know that there is a structure called the afterbirth, the foetal membranes which surround the foetus, or young animal, when in the womb and which are expelled from the womb shortly after birth, or even at the time of birth. In the case of the cow, on the outer of these membranes are a number of raised reddish roughened areas, the foetal cotyledons, sometimes known as " buttons " or " rosettes." This outer membrane has been in contact with the wall of the uterus and the cotyledons have been wrapped round prominences on the wall. These prominences are called maternal cotyledons. It is this arrangement of foetal and maternal cotyledons that is responsible for supplies that the calf needs for life and growth—especially nourishment and oxygen—and for the removal of much that is useless or even harmful to the calf in the form of waste products.

For these purposes blood from the calf leaves and returns to its body in the course of its circulation by passing along blood vessels in the navel cord. The outgoing vessels form branches, a branch going to each of the foetal cotyledons which, it will be remembered, are in intimate contact with similar structures in the wall of the womb. In these cotyledons the blood enters many tiny thin-walled channels or capillaries which mingle very closely with similar tiny blood vessels carrying the mother's blood and coming from the wall of the womb through the maternal cotyledons. Exchange of gases and other substances takes place through the extremely thin walls of the capillaries and so the blood of the calf receives what it requires and gives up what it does not need. The calf has its own blood which is distinct from that of the mother and although the two come into close contact they do not mix. It is hardly necessary to state that some such method of sustaining life in the calf is essential because it can neither eat nor breathe while in the womb.

Protection of Unborn Calf.

In the uterus the calf is enclosed in an inner membrane which contains fluid, the calf being suspended in the fluid which acts as a buffer and protects it from injury. A further essential purpose of this fluid will be described later.

Differences in Other Female Animals.

The structures first described as providing nourishment for the calf in the womb are not identical with those present in all female animals when they are pregnant. In some the exchange of gases and nourishment takes place over a large continuous part of the womb instead of in cotyledons only, which are not present. In others it is carried out only over a comparatively small raised area. Also, when more than one foetus is present each has its own foetal membrane and separate arrangement for receiving nourishment.

The Calf is Born.

The act of giving birth to the young is brought about by contraction of the muscular walls of the womb and by the necessary opening up and expansion of the os of the uterus along with increase in size of the vagina and vulva. Waves of contraction pass along the womb towards the vagina, each wave causing the animal a birth pain. At first the contractions are not very forcible and there is a considerable interval between each. The foetal membranes containing the fluid and the calf are gradually pushed backwards against the os of the womb which has commenced to open. A portion of the membranes and fluid, commonly called the water bag, is gradually pushed through the partially opened os which, as a result, opens still more until it disappears, forming a continuous passage with the vagina. In the meantime the contractions of the uterus have been becoming more forcible and frequent and eventually the membranes burst and the fluid is released. The fluid is a most efficient and lasting lubricant and it serves to aid passage of the calf. Very forcible uterine contractions, and of course pains, follow each other in quick succession until the calf is expelled, normally head first with the fore legs extended in front. The membranes are expelled sometime later forming the afterbirth and the uterus contracts, eventually attaining approximately its original size.

Importance of the Female.

It will be appreciated that, apart from pets, a great deal of the value of many of our female animals depends on their capacity to breed. Of course, mares are kept largely for their usefulness as working animals, and the same applies to other species, and many serve useful lives without producing young. However, on the whole the success of the livestock industry depends largely on the maintenance of healthy females which will give birth regularly, so that diseases which influence the rate of reproduction are of the greatest importance.

Breeding Troubles.

Swine breed fairly regularly and are not greatly subject to breeding troubles. Mares not uncommonly are difficult to get in foal, not so much because of disease but apparently because the body of the modern animal on occasion is incapable of or slow in performing the function of reproducing its species. Of all domestic animals however perhaps breeding troubles occur more commonly in dairy cows than in any others. Of course, because of the greater number of these animals this may be more apparent than real,

and again, since a cow is useless if she cannot produce calves regularly and maintain her supply of milk, breeding upsets are vital to the industry. Genital diseases which affect cows can also affect other animals but again the cow will be taken as type.

Cysts and Other Troubles in the Ovary.

It is not common to find disease of the ovaries caused by bacteria. On the other hand, upsets to ovulation can and do occur frequently. Sometimes a cyst, or accumulation of watery fluid in a membrane may develop on the ovary in the place of the ovum. This may happen at successive ovulations but the presence of even one cyst will completely upset the breeding cycle. In cases where cysts are developed at frequent intervals the animal will come on heat frequently, will shown an almost constant desire for the bull and will be difficult to manage. This condition is called nymphomania. More frequently only one persistent cyst is present. If one, or not too many cysts are present they can be removed by pressure properly carried out, but they tend to recur. A second attempt at removal will often meet with success and normal breeding activities will be resumed.

Again, when the ovum is released from the ovary, the normal occurrence is that a solid yellowish body is developed in the site of the discharged ovum. If the ovum is fertilized and the animal conceives, this body, called a *corpus luteum*, will persist and a secretion which it produces will have an influence on the life and development of the calf in the womb. This secretion also has the effect of preventing the cow from coming into season while it persists, that is until the cow calves. However, sometimes the *corpus luteum* is formed and persists when the cow has not conceived. When this happens the cow will not come into season and she cannot breed. This condition, known as retained *corpus luteum*, can be overcome by squeezing it out of the ovary. If it does not come away cleanly a second attempt may have to be made and once it has been completely removed the animal should " come bulling " within a few days.

Means of Treatment.

The reader may be rather mystified as to how a cyst or a *corpus luteum* can be removed from the ovary by pressure, that is by squeezing it out, considering that the ovaries are inside the body, apparently in an inaccessible position. Actually it is quite a simple matter in the hands of the expert. The hand and wrist are inserted into the rectum, that is, into the bowel and each ovary can be felt through the flaccid wall of the bowel. It is possible to pick up the ovaries, inside a fold of bowel of course, and manipulate them between the fingers and thumb.

Another upset to breeding is sometimes caused by the ovaries ceasing to function for a time, and this is particularly liable to happen during the winter. No ova become mature and none is released from the ovaries and the animal does not come into season. This condition of refusing to breed is quite common in maiden heifers and it is possible that many of such cases are caused by malnutrition though in some cases the reason cannot be ascertained. Appropriate injections may overcome this state of affairs but it must be admitted that further research into its causes and treatment is necessary before treatment can be relied upon.

Commonest Cause of Sterility.

Probably the commonest cause of temporary infertility in dairy cows is infection of the mucous membrane of the uterus by bacteria, sometimes extending to the fallopian tubes and frequently involving the vagina as well. This condition can vary from mild, when there really may be little damage done, to severe, when there is considerable inflammation of the lining of the uterus and an accumulation of pus. In such cases there is commonly a white discharge expelled at intervals from the vagina and among farmers the condition is known as " whites." Whatever the severity of the disease the mucous membrane of the womb is in an unhealthy condition and is incapable of supporting and nourishing a developing fertilized ovum.

Metritis.

Also, it is possible that the unnatural state of the vagina and uterus may prevent the survival of sperms for a sufficient length of time to allow fertilization of the ovum to take place. The technical term for such an affection of the uterus is endometritis, or if pus be present, suppurative endometritis. When the vagina is involved vaginitis is present as well. As a rule such affections cause little or no upset to the general health of the cow. An exception, however, is an acute endometritis which often follows a difficult calving in which the cow has had to be helped by manual interference. In such cases the animal is very ill and may die.

Cause of Metritis.

The commonest cause of chronic infection of the lining of the uterus is penetration of bacteria after calving. Also, if the afterbirth is not expelled reasonably promptly bacteria invade it and cause it to putrefy. In cows this happens fairly frequently and the condition of retained afterbirth is one of the common occurrences requiring veterinary interference on a dairy farm; the membrane has to be removed by hand. When the afterbirth is retained and putrefies, it is a common occurrence for the lining of the womb to be affected with bacteria also. In other cases of retained afterbirth no trouble follows, while some womb infections may occur although the membranes have been expelled quite quickly;

in this latter circumstance a dirty discharge from the womb may arise and persist, showing that infection is present. Again, in some cases, there is nothing to indicate that the uterus is infected. Cows rendered infertile by infection of the womb come in season regularly but fail to conceive even with frequent services from the bull.

Vaginitis.

Very often when infection of the uterus is present the vagina shows some inflammation as well, particularly when there is a discharge from the womb. Vaginitis is readily diagnosed since the vagina can be inspected and treatment of many such cases of vaginal inflammation has been unsuccessful because it has not been realized that the real seat of the trouble has been the womb. However, vaginitis by itself can occur and this alone can prevent a cow from breeding; the cause is a localized infection and it may be a condition transmitted by the bull or by the hands of people examining cows for the presence of the disease. Small red eruptions or even ulcers are to be seen on the lining of the vagina and the same condition affects the genital organs of the bull.

Successful Treatment.

Treatment of genital infections in cattle meets with a fair degree of success. In very acute cases after calving modern drugs of the sulphonamide type sometimes give very satisfactory results. In recent years a great deal of attention has been paid to the more chronic infections of the uterus. In the writer's experience appropriate treatment, if carried out thoroughly and frequently enough, results in a high percentage of cures. One thing must be stressed however; the earlier the treatment is carried out after the onset of the condition the greater is the chance of quick results. It is useless to take a cow to the bull a dozen times or so and then expect treatment to overcome the trouble at once. If a cow fails to conceive after three services it is time to have her examined and treated. Of course the question as to how many cases would clear up spontaneously always arises and it is probable that many, given time, would do so. The fact remains, however, that the delay so caused in getting cows in calf upsets the milk production plan and may lead eventually to derangement of an even supply of incoming heifers to the dairy herd. In the writer's opinion, based upon personal experience, cure of the condition results so very frequently immediately after a course of treatment adequately carried out that there can be little doubt that treatment is effective. The most difficult cases to deal with are those which show a copious white discharge and where the womb is enlarged and full of pus. Frequent treatments have failed to clear up such cases but in such cases, given time, and a spell at grass, nature on occasion works wonders; the unhealthy state of the womb may disappear and the cow eventually conceive.

NON-CONTAGIOUS DISEASES (Concluded)

The Blood and Circulation

Frequent mention of blood and the blood-stream in previous sections has made it necessary to describe them here. The action of the heart, the course of the circulation and the purpose of blood are explained. One disease of dairy cows, milk fever, is discussed because its cause is a deficiency in blood; the history, course, symptoms and cause are dealt with and the reason why treatment is successful is explained.

In the first three sections of this book blood and blood vessels have been mentioned quite frequently and it is proposed now to give some account of the mechanism and purpose of blood circulation, it being assumed that everyone knows that blood circulates through the body.

The principal force behind blood circulation is the heart which acts as a pump, forcing blood out from itself, through the whole body and back to the heart. The heart, a hollow organ composed of strong muscle and shaped something like a wide cone, is situated in the middle of the chest and lies between the lungs. It is covered with and supported by folds of pleura reflected back from the lining of the chest cavity. These folds extending from above to below the heart, adhere to one another forming one partition but they open out in the middle to enclose the heart. This heart covering is called the pericardium.

The Heart.

The heart is divided into four chambers by partitions running lengthwise and across its cavity. The two chambers towards the point of the cone are the right and left ventricles and the two at the wide end are right and left atria, often called auricles. There are no connections between chambers on one side of the heart with those of the other. The two on the left side however are connected by an opening as are the two on the right side and these openings are provided with one-way valves so that blood can flow from atria to ventricles but not back again. From each ventricle, a strong wide blood vessel, a main artery leads out into the body; these also have valves which will allow blood to leave the heart but not to return to it. Into the atria at the wide end of the heart pass large veins, one into each, and these vessels carry blood into the heart. Here again, although no actual valves are present, contraction of muscles round their entrances to the heart prevents backflow of blood.

How the Heart Works.

Now, when the heart contracts, the contraction takes place as a wave, commencing at the wide end of the heart, in the walls of the atria; this first closes the openings from the veins which enter these compartments. The wave then passes towards the ventricles forcing blood contained in the atria through the openings between atria and ventricles. The atria are thus emptied of blood and the contraction then passes down to the ventricles. Then, the valves between atria and ventricles close, those at the entrances to the large arteries which leave the ventricles open, and blood under very considerable pressure is forced into these arteries in a wave. Now the heart starts to expand again. The valves guarding the arteries close, preventing any backflow of blood into the heart. Expansion of the heart opens the inlets from the veins into the atria and the valves between atria and ventricles also open. Blood flows into the atria again from the veins and runs down through the open valves between atria and ventricles. Contraction commences again, the veins close, the atria are emptied into the ventricles and the whole process is repeated.

Having learned how the heart acts as a pump and how blood is forced out through arteries, one of which leaves each ventricle, right and left, let us trace the course of blood through the body.

Arteries and Veins.

In the first place arteries, which are strong elastic tubes, carry blood away from the heart under pressure, whereas veins, which are much less strongly constructed, carry blood back to the heart, eventually to the atria. The system of veins in the body is of greater capacity than the corresponding system of arteries and that capacity is enlarged as the heart is approached. This means that although blood in arteries is under pressure that pressure is lost when the veins are reached and becomes less and less the nearer the veins approach the heart. The flow of blood in arteries, in a series of waves, each wave corresponding to a contraction of the heart and constituting a pulse beat, is comparatively fast but in veins, the driving power of pressure having been lost, the flow is more sluggish. For this reason the larger veins are fitted with valves at intervals so that blood cannot flow in the reverse direction. Movement and exercise accelerate the flow of blood through veins—by reason of the movement of body muscles—as well as causing a more forceful and frequent beat or contraction of the heart.

Circulation Through the Lungs.

The artery which leaves the right ventricle carries blood to the lungs. It sends branches to each lung and each of these breaks up into smaller and smaller branches until the finest of all, capillaries, are reached. Capillaries are minute in size and have very thin walls; many of them in the walls of the lung spaces. After having carried blood to the lung spaces the capillaries begin to join together again on their way back to the heart, forming veins; these in turn also join together forming larger veins, until the single

large vein is reached which enters the heart at the left atrium. This vein carries only blood which left the heart from the right ventricle, passed through the capillaries of the lung spaces and returned to the heart.

Blood which reaches the lungs in the way just described gives up carbon dioxide to the inspired air in the lungs and takes up oxygen from it. This happens through the very fine walls of the capillaries present in the walls of the lung spaces. The blood conveyed to the lungs from the right ventricle plays no part in the nourishment of the lungs, this being obtained from blood which left the left ventricle of the heart as will be seen later. The sole purpose of blood coming in from the right ventricle is to receive oxygen from and give up waste gases to the air which has been breathed into the lungs. Also, it will have been noted that this blood returns to the *left* atrium of the heart.

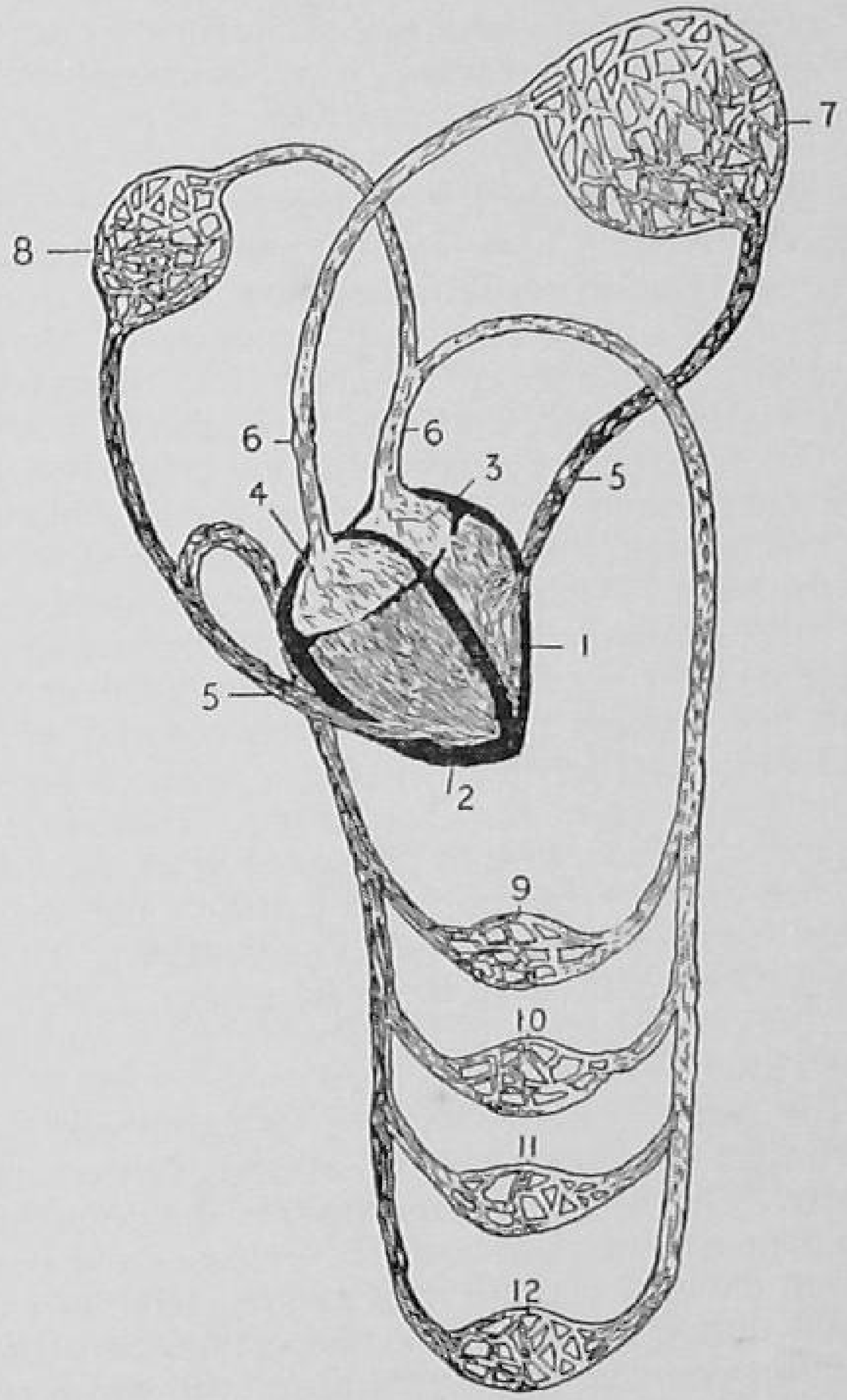
How Blood goes Through the Body.

Blood which leaves the left ventricle of the heart is destined to circulate through the whole body. It leaves the heart in the strongest and largest artery of all, the aorta. The aorta soon divides into two branches one passing forwards towards the head the other towards the hind part of the body. These, in turn, give off branches; some of them pass to limbs and others by repeatedly dividing up into further branches are distributed to all the organs and tissues of the body, even the lungs and the heart wall itself being supplied by this means. As they go on the arterial branches become smaller and smaller and eventually break up into capillaries which are present in every organ and tissue of the body. The capillaries then join together again forming veins, which, on their way back to the heart join up with others eventually forming the single large vein which enters the *right* atrium, this carrying all the blood which left the left ventricle and has circulated through the whole body. This will then pass to the right ventricle and thence through the lungs.

It will be seen then that blood, in turn, passes through the lungs to give off waste gases and receive oxygen, then, laden with oxygen, it sets out on a journey round the body after which it is again returned to the lungs.

Blood, in its journey through capillaries in the walls of the intestines receives nourishment which is absorbed from the food there, so that on its way round the body nourishment as well as oxygen is supplied to all tissues. It also receives waste products from all parts and many of these are given off in the kidneys, to be passed out in urine. Waste gases are given up to air in the lungs and some are got rid of in sweat.

Now, how is the blood able to do all this? It is composed of a fluid part in which float millions of tiny cells. The cells are of two main kinds, red corpuscles and white corpuscles. The white are explained in another part of this book and nourishment, oxygen and other substances are carried by the fluid and red corpuscles. A substance in the red corpuscles called haemoglobin is capable of uniting with and carrying oxygen but it gives it up readily where and when required. The fluid part of blood carries the nourishment in solution and this fluid passes out through the walls of the capillaries which are present in or closely associated with all body tissues. In the tissues also haemoglobin gives up oxygen to the blood fluid and that also is brought into contact with all tissues. In a similar manner waste products and carbon dioxide are taken up by the blood fluid. The carbon dioxide unites with the haemoglobin to be carried to the lungs in the red corpuscles. Red corpuscles carrying carbon dioxide are bluish in colour and when carrying oxygen they are bright red. This is why the blood in veins is blue and that in arteries of a red colour. Of course if a vein is allowed to bleed the carbon



CIRCULATION OF THE BLOOD

1. Right ventricle. 2. Left ventricle. 3. Right atrium. 4. Left atrium. 5, 5. Arteries. 6, 6. Veins. 7. Circulation in the lungs. 8. Circulation through head and fore limbs. 9. Circulation through intestines and liver. 10. Circulation through kidneys. 11. Circulation through genital organs. 12. Circulation through hind limbs and tail.

dioxide is very quickly given up and oxygen received from the air so that the blood appears red.

(ii)

Animals are not greatly subject to diseases of the blood circulation such as hardening of arteries which results in development of blood pressure and heart strain. On occasion, disease of the heart valves is found and the heart muscles can be affected as part of a general disease. This happens quite frequently in infectious diseases and even in some non-infectious conditions such as pneumonia. Here also extension of infection from the pleura, that is in pleurisy, can involve the pericardium resulting in pericarditis.

Milk Fever.

There is one disease however which occurs commonly in cows and also in other female animals which, although not due to an upset in the blood circulation, results from changed composition of the blood. It has become known, and will continue to be known as milk fever, and this is correct in so far as it has to do with milk production, but it is not a fever, because the affected animal's body temperature remains normal or is even slightly below normal throughout.

Milk fever usually occurs in cows at or just after the time of calving and it is most common in these animals when they are at the peak of their milk yield, that is, when they have had their third or fourth calf. It is usual to find it also in heavily yielding cows but it can occur in animals of any age irrespective of milk yield, though it is rare in heifers with their first calves. Also, cows have been known to be affected months after calving.

For many years the cause of milk fever baffled those who were interested in the disease. Up to sixty out of every hundred cows affected died and it had been known for about one hundred and twenty years before the true cause was definitely established. In the meantime however, some ninety years after milk fever was first reported, a treatment was devised which saved large numbers of affected cows, the death rate falling to about one in every hundred.

A Danish veterinary surgeon held the theory that milk fever was caused by some poisonous agent or infection in the udder. Consequently he injected a solution of mild antiseptic into each teat until the udder was comfortably full. This was found to cure, and cure quickly, the great majority of cases of milk fever. Following this, different solutions of a bland nature were tried with equally successful results until it was discovered eventually that pure sterilized water injected into the udder would also cure the condition. This indicated the possibility that the curative action might be due entirely to pressure of the fluid in the udder. Acting on this assumption the next procedure was to try inflating the udder with air and this also achieved the desired result. For many years this constituted the only treatment for milk fever and so successful was it that a cow, obviously dying of the condition would be sitting up and eating a few hours after treatment. Mammary inflation, as it is called, as a treatment for milk fever proved to be one of the greatest discoveries made in the battle against disease of dairy cows.

True Cause.

Successful as the treatment was, nevertheless it made the actual cause of the disease still more obscure in that it obviously was not the affect of antiseptics in the udder that overcame the malady. Some twenty years ago however the true cause of milk fever was finally established. Research workers showed that in all cases of the disease the amount of calcium which was normally present in the blood was markedly reduced and that quick recovery took place after injection into the body of calcium in a suitable form.

Calcium.

Certain body functions are affected by the amount of calcium which is present in blood. A fall in the amount below a certain limit will lead particularly to an upset in the control over muscles, and the brain and consciousness are affected as well, the severity of the symptoms varying in degree with the severity of the disease.

A large amount of calcium is present in the first milk after calving, that is, in colostrum. This calcium is obtained from the blood and results in a severe draining of calcium from that source. Normally, to make up the depleted supply of calcium in the blood, the blood system obtains it from bones of the body, where there is always a plentiful supply. When heavy yielding cows have calved, a great strain is put upon the mechanism which controls the blood calcium level and, in milk fever, calcium is not mobilized from bones sufficiently quickly to make up the loss. When this disease occurs some time after calving, it is still due to an upset in the calcium-controlling mechanism, but in these cases the cause of the trouble is not quite so clear.

Inflation of the udder stops the production of milk for a time, so this temporarily brings to an end the loss of calcium from the blood stream. In this way the calcium-controlling mechanism is able to adjust itself to the new conditions and, twenty-four hours later, when the air is usually drawn off from the udder, everything is functioning normally. Injection of an adequate amount of calcium into the body more than replaces that which has been lost from the blood and before this has been used up the mechanism is usually working properly again; this is the modern treatment and it is in almost universal use; it has the

advantages of being based on a true understanding of the condition and does not involve interference with the udder, a practice which should be avoided whenever possible. Treatment commonly results in a quick cure, the animal being in full possession of its senses and feeding normally within a few hours. Some cases however relapse and the treatment has to be repeated; in rare instances a number of treatments have to be carried out before cure is complete.

Symptoms of Milk Fever.

The symptoms of milk fever exhibited by different cases are not identical. A number of things can happen and one rarely sees all of these present in the one animal. Stiffening and contraction of muscles are very common and one of the first things that may be noticed is that a lies on the shoulder. If the neck be forcibly straightened and then released it will be returned to the same position. This posture is caused by the contraction of muscles on one side of the neck and not on the other. At this stage the cow will not be wholly conscious and consciousness will be lost progressively until the cow lies flat on her side with the head and neck stretched out in front and pulled back slightly. There she will remain cold and unconscious and will probably die if not treated.

The veterinary surgeon never wastes any time when called to a case of milk fever. The various stages of the disease may follow each other rapidly and the cow be in a condition of collapse quite quickly. Even so, treatment, if not delayed for too long, commonly results in quick and spectacular recovery.

Typical Position of Cow with Milk Fever

cow is standing with the hock joints of the hind legs abnormally straight and stiff. They are bent only with difficulty and the animal transfers weight from one leg to the other in the so-called " paddling " movements. If walking she will be seen to move stiffly and perhaps stagger occasionally; progressive loss of control of the limbs becomes more and more evident. As time goes on also, the affected cow may become quite violent, showing convulsive and sudden movements of the head and limbs, throwing herself about in her stall; at this stage she can easily injure herself. If the disease remains untreated the animal will eventually lose all control over her limbs and fall down and after a few ineffective efforts to regain and remain on her feet, she will remain lying. Then the typical posture of a cow with milk fever will probably develop. The head and neck will be turned round so that the head

Nursing.

The nursing of a cow with milk fever is of the utmost importance, as is the period of after-treatment and convalescence. When the presence of the disease is suspected the cow, if able to move safely, should be removed to a well-bedded loose box. If the condition is too far advanced for this however, as is often the case when an ailing animal is first seen in the morning, her neighbour in the stall should be turned out and plenty of bedding placed in the stall. If the attack occur when the animal is at grass and if it be daytime and the weather be fine it will not do her much harm to remain where she is. On the other hand at nightfall, or in cold or wet weather she should be brought in. If the animal be unable to walk removal can usually be effected by dragging her in on a float or even on a door removed from its hinges for the purpose. When in a box or stall

the sick cow should not be tied up after reaching the stage of not being able to remain on her feet. Under no circumstances should a cow with milk fever, or any other disease for that matter, be allowed to remain lying flat on her side. When in this position gas accumulates in the rumen and the pressure so developed causes considerable difficulty in breathing; it also produces other dangerous effects which if unrelieved will together kill the animal. Bags filled tightly with straw or bales of straw should be packed close into her sides particularly at the shoulders so that she cannot fall over and her position should be normal and comfortable. Rugs or sacking should be placed over her and kept in position for warmth. Constant watch must be kept in case she should struggle over on to her side; if this happens she should be raised again without delay. It is very dangerous to dose a cow affected with milk fever with liquid medicine given by mouth, unless it is absolutely certain that she is fully conscious. Many animals have been lost in this way; for a partly conscious animal is not able to swallow properly and the result is that medicine may enter the lungs and set up inhalation pneumonia with fatal results. Milk should not be drawn off in any quantity from an affected cow because such a course will serve to aggravate the condition; at most the udder should be eased.

After-Treatment.

After-treatment consists in bringing the cow back very gradually to full milk. Only small quantities of milk should be removed from the udder at any one time, because emptying the udder may precipitate a relapse. It is good practice to give the calf access to the cow for a day or two and to leave milking to it. Similarly if a cow has shown previously that she is susceptible to milk fever an attack may be prevented by either of these means. In any event she should not be completely milked out after calving.

A condition identical with milk fever is known in goats, sows, ewes and bitches and all respond to calcium injections. In ewes it is usually called lambing sickness and commonly occurs just before lambing.

Lowered Magnesium.

Symptoms somewhat similar to those of milk fever are to be found in cows suffering from a lowered magnesium blood content. This responds to injection of magnesium in the proper form and is not connected with calving and milk production as is milk fever. The symptoms of this disease are usually of a more violent nature, the animal sometimes showing great excitement, sudden movements, quivering of muscles and sweating.

THE CAUSES AND EFFECTS OF CONTAGIOUS DISEASES

Here is an introduction to the study of infectious diseases of animals. The causes of infectious conditions are explained and the means by which they produce disease discussed. That the body is not powerless against such attacks is shown by a description of the forces which are mobilized in defence. They can be stimulated artificially and considerable protection against disease can be attained by the use of sera and vaccines. The utilization of such methods in prevention of disease is described.

(i)

When a disease is contagious or infectious it means that it can be transmitted from one animal to another either by direct contact or, in many cases, by indirect means. Most minor ailments do not come into this category but many diseases of animals which are of serious economic importance to the farmer are capable of spreading from one animal to another.

Producer of Disease.

Now, why should certain types of disease exhibit this ability to spread? The natural conclusion is that whatever causes the disease must be capable of being transmitted and this is exactly what happens. All infectious or contagious diseases are caused by living agents—microbes, germs or bacteria or by viruses. The world is full of these extremely small living things but fortunately not all produce disease and indeed most do not affect animals or man at all. Moreover, some bacteria are definitely useful such as certain of them found in soil; these bring about chemical changes in certain constituents of soil which are of advantage and even essential to growing things. However, a number of germs have acquired the ability to invade the bodies of man and animals and to set up disease there; indeed many with these habits can exist solely by this means. On the other hand certain microbes which cause disease do not show any tendency to spread to other animals and such diseases cannot be called contagious or infectious. In such cases the bacteria are usually normally present in the body and generally harmless; under certain circumstances however when the body resistance is lowered, disease results from their activities; this is true in many forms of pneumonia where body resistance is often lowered by chilling or by some other disease.

Types of Bacteria.

All living agents which cause disease are parasites in that they live in the body and at the expense of the body of the animal which is being attacked. Everyone knows of the existence of these organisms and most have their own conception of them. A common fallacy is to imagine them as little insects with legs and possibly wings but nothing could be farther from the truth. The fact is that the greatest number of disease-producing organisms, the bacteria, belong to the vegetable kingdom and constitute the very simplest forms of plant life. They are extremely minute in size and are quite invisible to the naked eye. Millions can occupy the area covered by a pin's head and they differ in shape and habit according to their genus or type. Some are rod shaped (*bacilli*), some are globular and appear in chains like strings of beads, (*streptococci*), some are of similar shape but exist in clusters (*staphylococci*), while a few less well known have an elongated spiral form. Some fail to grow and multiply in the presence of free oxygen and these are known as *anaerobes*.

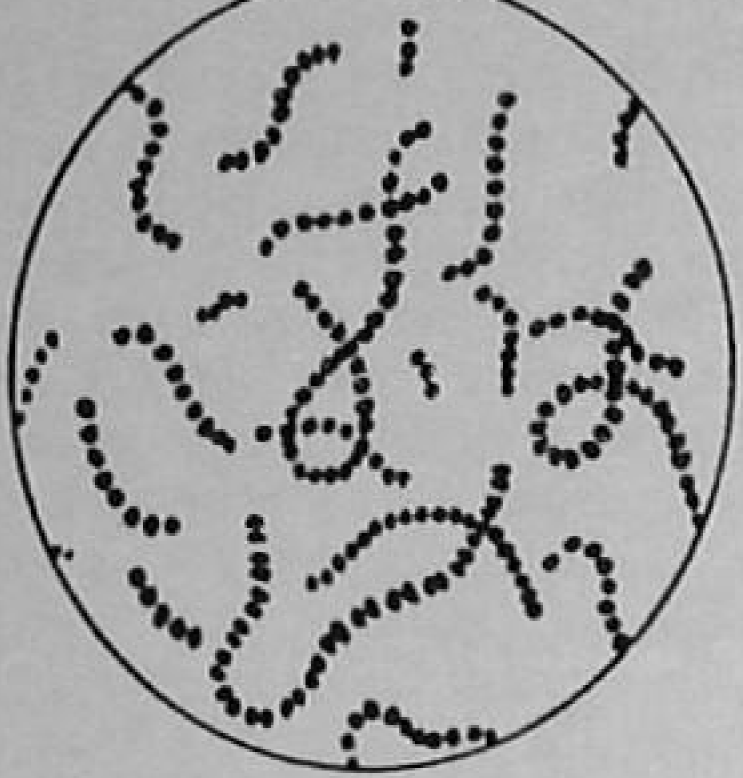
Viruses.

Viruses have been mentioned as being able to cause disease. These differ considerably from bacteria and indeed their composition and structure is as yet not properly understood. It is known however that they are many times smaller than bacteria and the ordinary microscope cannot reveal them, hence they are often called ultra-microscopic viruses. They are also called filtrable viruses since they are capable of passing through very fine filters which would hold back bacteria. It is certain that disease viruses multiply in the body which they are attacking and a feature of all virus diseases is that they are exceedingly infectious. Examples of virus diseases are the Common Cold and Measles in man and Foot and Mouth Disease and Swine Fever in animals. In general the behaviour of viruses as disease producers is identical with what we find in bacteria, so that subsequent accounts of the behaviour and habits of bacteria and the reaction of the body to them will apply also to viruses unless the contrary is specially stated.

A third but small class of disease-producing living things are the Protozoa, some of which attack animals. These constitute the most primitive and most minute forms of *animal* life, in distinction from bacteria which, it will be remembered, are of the *vegetable* kingdom. Few animal diseases are caused by Protozoa in this country. Higher forms of animal life especially worms are also implicated in the causation of disease especially when they exist as parasites in the body.

When bacteria find themselves in suitable circumstances they can multiply very rapidly. Multiplication is achieved by each single organism dividing into two; one becomes two, two become four and so on and one million can become two millions in a short space of time. This is what happens when a susceptible animal is attacked by any of these germs—the disease-producing agents may multiply quite rapidly

once they have become accustomed to their surroundings. Disease symptoms are not produced until germs are firmly established, have multiplied considerably and have commenced to attack the body in sufficient numbers to make their presence felt. The time to do this, that is, the time which elapses between infection (the first entry of bacteria into the body), and the development of disease symptoms is called the *incubation period* of the particular disease. This period may be a matter of hours, days, weeks or even months. In Anthrax it may be a few hours while in Johne's Disease of cattle it is a matter of many months.



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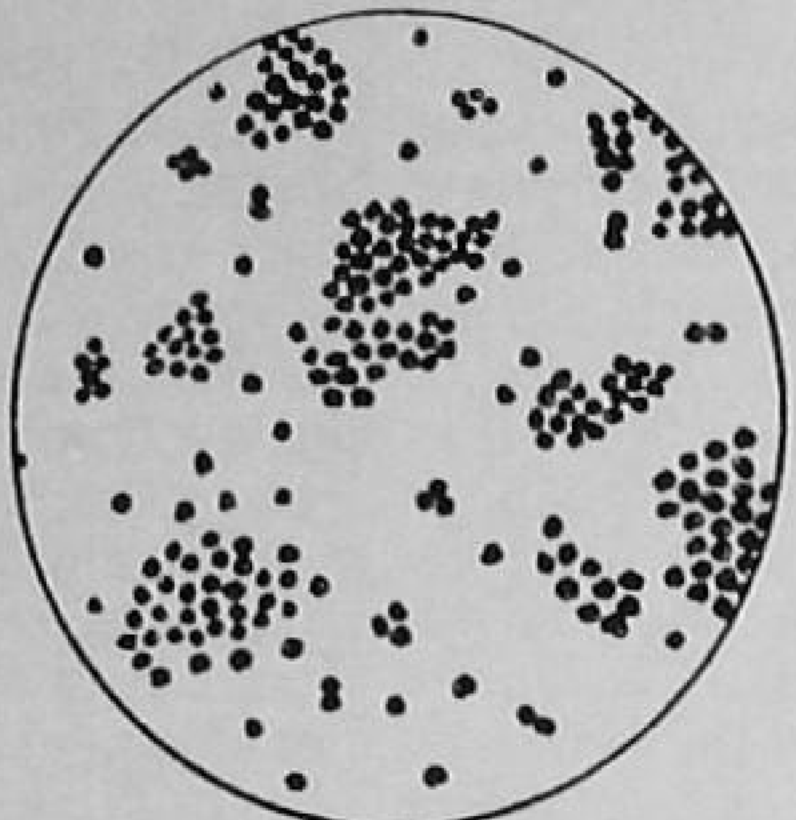

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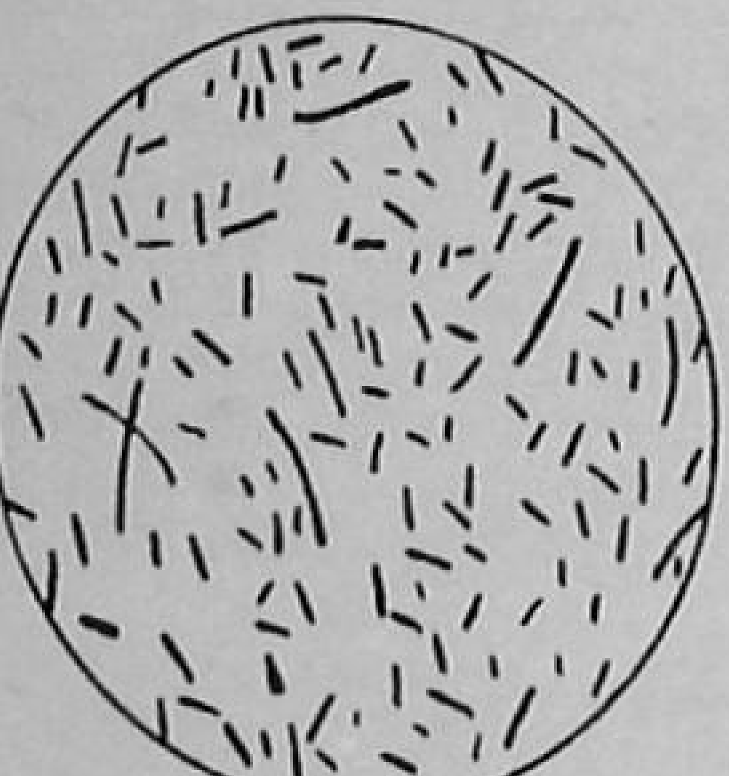
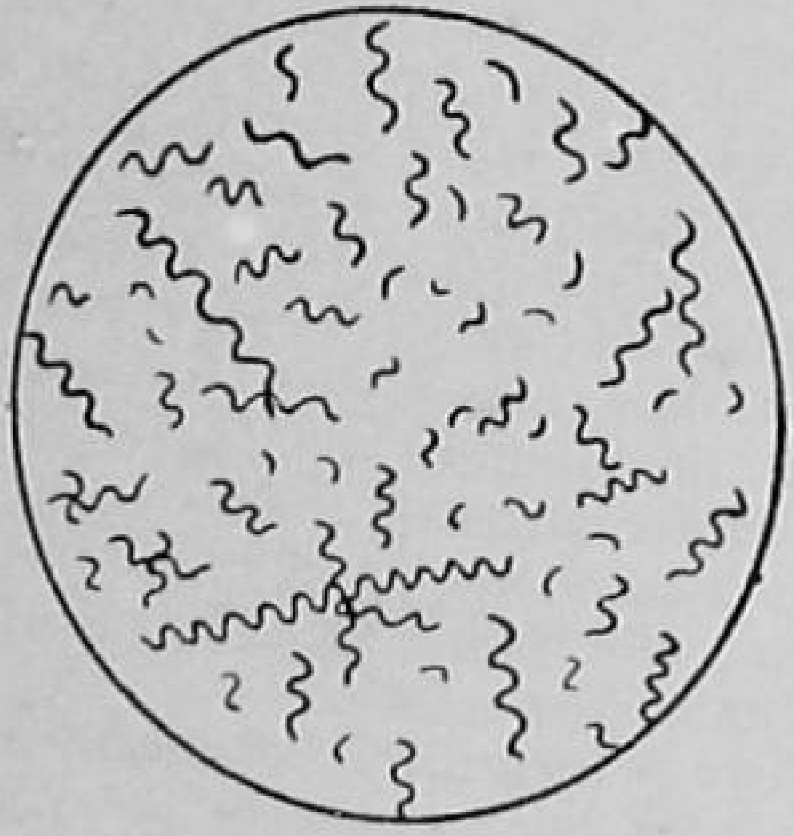


BACILLI



SPIRILLI

TYPES OF BACTERIA

It should be understood that each species of bacterium will usually cause only one disease. For example the germ of tuberculosis can cause no other ailment and that causing contagious abortion in cattle can have no other effect upon female cattle.

The Ways of Disease Bacteria.

One other feature of certain bacteria is worthy of note and has a bearing on their ability to produce disease. Some organisms can change themselves into a form which is extremely difficult to kill; these are known as the spore-forming bacteria and many such are to be found among the anaerobes. When they find themselves in unsuitable circumstances for growth and multiplication they proceed to transform themselves into minute globes or spheres which have extremely thick walls and are very resistant to the action of disinfectants or other bacteria-killing agents such as heat or direct sunlight. These spores as they are termed may exist in some cases for many years in soil and other sites and then if the organism once more finds itself in congenial surroundings, such as those provided by the body of a susceptible animal, it will change again into its original form (usually a bacillus) and commence to reproduce itself. There is no evidence to suggest that viruses form spores. It will be realized that spore-bearing germs are extremely difficult to eradicate from anything that may be contaminated with them. Indeed, it is known that certain of them can exist in soil for many years and can withstand boiling in water for some minutes.

We have now learned something of the nature and habits of bacteria and their relationship to contagious disease but we have yet to enquire into the methods by which they cause disease. The mere fact of the presence of some millions of minute living things in the animal body would not seem to be adequate reason for the development of disease. The fact is that bacteria of disease have an inherent ability to act upon the living body tissues to their own advantage and to the detriment of the animal.

How Bacteria Cause Disease.

It has been stated that disease bacteria are parasites which live at the expense of their host. Some confine themselves to particular sites in the body and their immediate effects are felt there only. Tuberculosis may again be quoted as an example. The organisms may have lodged in the lungs or in certain glands, in the udder or other sites. They act upon neighbouring tissues in order to gain their own nourishment but in the process they destroy those tissues. Indeed some bacteria actually have the power of dissolving the parts of the body with which they are in contact. Most organisms become localized at one or more parts in the body but there are exceptions. In cattle and sheep the anthrax germs usually invade the

body as a whole and they can be found in the blood stream and in every organ. The ability of bacteria to invade, to persist and to multiply in the body is termed *virulence*. Bacteria differ greatly in virulence, the least virulent causing only localized conditions such as abscesses with few if any remote effects and the most virulent invading the whole body often causing death. When the blood stream is invaded and the organisms persist there the term *septicaemia* is applied but blood poisoning is the every-day term for this development.

Virulence.

It will be seen then that apart from the damage that bacteria can do to body tissues their power to get there and to persist there, that is, their virulence must be taken into account. When considering virulence however it has to be remembered that a particular species of germ may be more virulent to one individual than to another. The ability of the animal to resist the germ must be taken into account. Bacteria will gain a footing in a susceptible animal much more readily than they will in another of the same type which is more resistant. It is a fact that, of a number of animals of the same age and species which are being fed and housed similarly and which are being treated identically in every way, some will prove to be more susceptible to a particular disease than others.

Remote Effects.

Apart from the effect of bacteria on the actual tissues of the body with which they are in contact many have the ability to produce much more remote effects. This is due to the fact that many produce a poison or *toxin* which rapidly spreads through the body, in some cases with disastrous effects. One type of toxin may be liberated by the breaking up of dead bacteria but much more active is the toxin which is produced by certain living germs. The best example of this latter type is to be found in tetanus or lockjaw where the germ remains in a wound and the toxin, because of its more general effects, causes the well-known symptoms of this disease and often death. The effect upon the body produced by the toxin of one particular species of germ is always the same and differs from that produced by any other. That is, bacterial toxins are specific in their effects as are the different species of bacteria themselves.

The response of the body to infection with bacteria also adds its quota to the general illness which may result. Thus there are probably a rise in body temperature, an increased rate of heart-beat and breathing; there may be diarrhoea or excessive discharge from some other part of the body and these reactions do not contribute to a feeling of well-being on the part of the animal. No one feels well with a high temperature for instance.

(ii)

Resistance.

We have seen how disease-producing microbes can invade the body, but it must not be imagined that the animal body is defenceless against such attacks. Some animals have an unassailable resistance to certain diseases which cannot be broken down under any circumstances. For instance horses are never affected with foot and mouth disease or cattle with swine fever. Particular disease attack certain species of animals and them only.

Body Defences.

Apart from this however there are certain body defences which come into action when an animal becomes infected with a disease; indeed, these defences may completely prevent the development of the disease. In other cases the bacteria may gain a footing and produce illness, slight or even very severe in character but the defence mechanism eventually overcomes the invaders and the animal recovers. Unfortunately however in some cases, such damage may be done to a vital organ or organs that the animal dies before the body has had time to mobilize an effective defence. In some few cases, and in certain circumstances, there appears to be insufficient reaction on the part of the body to overcome the condition and the invading bacteria gradually make headway so that the disease is of a prolonged nature and slowly becomes more extensive. Such conditions are said to be *chronic* in nature as opposed to acute attacks when, generally speaking, the ailment is of shorter duration, is more immediate and severe in its effects, comes to a head more quickly and then is either overcome by the body or the animal rapidly gets worse and dies. Conditions which are of a mild nature cannot be called either acute or chronic since they never become severe and they rarely last for any length of time.

Inflammation.

In an earlier part of this book (p. 424) some description was given of the formation of pus and it was stated that this was largely composed of dead white corpuscles. These it will be remembered are minute cells which are present in large numbers in blood and elsewhere in the body and they have the faculty of being able to engulf bacteria and to destroy them. When disease germs gain entry into the body white corpuscles are frequently attracted to the spot in enormous numbers. This does not happen to the same extent with all bacteria, some having more attraction for the corpuscles than others. The purpose of these corpuscles is to kill off the invading germs and to prevent their progressing any farther. In the process the corpuscles themselves suffer many casualties. Apart from this attack on the germs the process which we term

inflammation is set up, wherein there are heat, pain, swelling, redness and tension of the part involved. Fluid is exuded into the affected area and the inflammatory process has the effect of limiting the spread of the condition and of concentrating body defences on the spot. When many corpuscles are killed off they remain in position, and together with the fluid which has been produced they form pus. The white colour of pus is given to it by the millions of dead white corpuscles that are present. From consideration of the fact that different bacteria do not attract white corpuscles to the same extent it will be realized why pus is not present in every case of infection with disease germs.

It must not be thought that the activity of white corpuscles in combating bacteria is limited to areas surrounding cuts and wounds through which disease organisms may enter the body. Whenever and wherever infection by bacteria is present in the body these cells are ready to begin the attack, a few at first but gradually assembling in hordes. They constitute an almost immediate means of defence.

However, many infectious diseases are overcome in the body by other or additional means which, although they take some time to develop, are more effective in the end. It is common knowledge that, in the case of many infectious diseases, one attack seems to leave behind it considerable resistance to further attacks of the same disease at a later date. This is because properties or substances antagonistic to the particular disease germs have been produced in the body under the stimulation of the first attack and persist for very considerable periods afterwards. They are there in the body ready to repel, at once, any future efforts of germs of that particular kind to establish themselves in the body. So important is this mechanism for overcoming and preventing infectious diseases that it merits attention in more detail.

Antibodies.

The protective properties or faculties which are developed in the body in response to infection are known as *antibodies*. They are present in the blood and therefore they can reach readily any site where danger threatens. In the first instance production of antibodies is stimulated by actual infection of the body with particular bacteria and the fact that antibodies are there at all is evidence that these germs must have established themselves in the body at some time, to some extent at least. The antibodies which are developed as a result of infection with one particular germ will give future protection against that germ, and no other; in other words, antibodies are absolutely specific in their action. For instance, in humans, an attack of scarlet fever will stimulate considerable resistance against future attacks but there will be no protection against say diphtheria, measles or any other unrelated infectious disease.

Antitoxin.

Bacteria which produce toxins stimulate the production of two kinds of antibodies. There are those which are directed against the bacteria themselves and others which have the effect of overcoming or neutralizing the toxins. This latter type of antibody is called an *antitoxin*.

Immunity.

When antibody protection against a particular disease exists in an animal it is said to be *immune* to that disease. The degree of immunity attained is variable in that it may be more lasting and of greater degree in one individual than in another. Also such immunity is rarely so effective that it will protect an animal against a massive dose of a germ; in such a case the antibodies are incapable of overcoming all the invaders; some persist and set up the disease. Again, the degree of immunity to a disease will wane as time goes on; it may last for years but it will gradually get less and less effective. In general, antibody immunity is the body's most reliable and effective protection against, and method of overcoming, infectious diseases; when it is already present it is usually strong enough to protect against any ordinary dose of infection. It takes some time to develop after infection is received, hence disease germs are able on many occasions to do much damage before they are killed off. This immunity is active in virus diseases as well as in those caused by bacteria. In some few diseases, the body shows little apparent antibody response to infection; this is the case in most chronic conditions.

(iii)

In the previous section of this chapter we have seen how the body can protect itself against and overcome diseases which are caused by bacteria and viruses. It will be realized that the stimulation of antibodies plays a great part in resistance to disease and because of this scientists have for many years endeavoured to develop methods by which antibodies against particular diseases could be produced in the body *without the animal actually having contracted the disease*, even in a mild form.

Immunization.

The possibility presented itself, that, if the germ of a particular disease could be introduced into the body in such a form that it would not give rise to the disease the production of antibodies might be stimulated nevertheless. Disease germs can be cultivated or grown in laboratories and the most obvious method of rendering them harmless was to kill them. This was done and it was found that in some diseases introduction of these killed bacteria into the body resulted in antibody production to a considerable degree. Experiments with this method of protection or *immunization* showed that it was completely

successful in a number of cases. In some diseases however it was found that killed germs would not give rise to any appreciable immunity, so another method was tried; the bacteria were treated in such a way that, although still alive, their ability to cause disease—that is their virulence—was considerably reduced. This was done principally by treating them with disinfectants such as formalin or phenol (carbolic acid) diluted to the extent that it would not kill but had a definitely adverse effect on bacteria. We can consider that such bacteria were definitely sick and so reduced in vitality that they could not persist and multiply in the body to the extent of causing disease. Nevertheless they could remain alive for a sufficient length of time to induce antibody production.

In general, it has been found that the immunity produced by the introduction into the body of killed bacteria does not last for much more than a year, but, to begin with at least, it may be of a high standard. This is of value in protecting animals over a short period when they are particularly susceptible or when they are in danger of contracting an infection, because of an outbreak in neighbouring animals or when an epidemic (or *epizootic*, as it is termed in animals) is raging. However there is an even better method of doing this as will be seen later. On the other hand when bacteria of reduced virulence are used for the purpose of immunization the resulting protection usually lasts longer than when killed organisms are used.

In experiments with the foregoing methods of immunization it was found that the greater the virulence of the bacteria used for this purpose the greater was the degree of protection which resulted and the longer it lasted. That is, if the bacteria used were only slightly less able to cause disease than normally, antibodies would be produced in the body in much higher concentration than would happen if almost dead bacteria were used. Consequently a very high degree of immunity could be built up by giving successive doses of germs, each being composed of organisms of greater virulence than the preceding dose, until fully virulent bacteria could be used. Every dose stimulated an additional production of antibodies sufficient to withstand the next stronger dose provided that between doses sufficient time elapsed for the development of antibodies in greater and greater degree, usually ten to twenty-one days. In such a way an animal could be made to withstand massive doses of some disease-producing germs.

Vaccination.

The methods of immunization which have just been described are used when *vaccination* is carried out. A vaccine is a measured number of bacteria usually evenly mixed in fluid so that if a measured quantity is introduced into the body one knows approximately how many germs have been used. The usual method of vaccination is to inject or inoculate the vaccine just under the skin or, in some cases, deep into a muscle by means of a hypodermic syringe and needle. It is useless to give a vaccine by mouth since the process of digestion will destroy it and in most cases it will not reach the system. It must be introduced directly into the tissues.

Direct Route.

It will probably occur to the reader that in vaccination against smallpox in man, a procedure familiar to most, no syringe is used and nothing is injected. Here the virus is rubbed on to scratches in the skin and gains entry into the body in this way. The important thing is that a direct route into the body must be provided. From this it will be realized that protection by vaccination is possible in some virus diseases. In general the procedure is identical with that used for bacteria with the difference that viruses cannot be cultivated in laboratories. This difficulty is surmounted by growing the virus in animals, that is, by infecting them with the virus. The animal is then killed painlessly and those organs which are rich in virus are removed from the body, dried, ground up very finely and mixed with fluid. This material is then treated in much the same way as are bacteria in order to kill or reduce the virulence of the virus. It is then used as a vaccine.

In some diseases, where the toxin of the bacteria is the real danger, it has been found that vaccine composed of bacteria alone did not give protection. Consequently methods have been devised for separating toxins from bacteria and reducing their potency, that is, their poisonous character. Such modified toxins can be injected into animals and the result is production of antibodies directed against the toxins, that is, of antitoxins. Another method of doing this is to give at first a minute, relatively harmless, dose of fully potent toxin and to follow at intervals with larger doses as immunity develops. In practice however, and for vaccination purposes, bacteria and toxins are usually mixed together in the one vaccine so that it will give rise to an immunity effective against both the bacteria and their toxins.

It will have been realized that one of the disadvantages of vaccination is that a considerable time elapses between the inoculation and the development of antibodies in sufficient concentration to give adequate protection. Immediate protection against a disease cannot be obtained. However a method has been devised wherein ready-made antibodies against a particular disease can be introduced into the body to give immediate protection.

Serum Containing Antibodies.

The reader is referred back to the description

of how a very high degree of immunity can be built up by injecting successive doses of germs of ever-increasing virulence. An animal treated in this way, in a case in which the process is carried to its absolute limit is the possessor of antibodies against the particular disease in very high concentration. The fluid part of the animal's blood, which is a pale straw-coloured liquid, will contain these antibodies. Now, if some blood is taken from the animal, the fluid part separated from the corpuscles, and if the fluid part be injected into another animal the antibodies will be introduced as well and the second animal will immediately become immune to the particular disease. The fluid part of the blood is called *serum* and, for giving immediate protection against disease, serum containing antibodies is used extensively against both bacteria and their toxins and against viruses. Such serum is now prepared in laboratories in large quantities and a store is kept of different sera to be ready for use as protection against different diseases. The immunity resulting from the use of such sera is quite temporary in character and usually lasts at its full efficiency for a few weeks at the most; after that it will gradually disappear. It is interesting to note that newly born babies and animals have a similar type of immunity conveyed to them in the first milk.

Antibodies which are present in the mother reach the young in this way and at this time of life, and only then, are the digestive organs capable of passing antibody into the system in an unchanged condition.

Still one other method of inducing a high degree of immunity is to inject the appropriate serum and then during the temporary immunity so produced, to inject a dose of the living, fully virulent, disease germs. This second injection converts the temporary immunity into one of very much longer duration.

Terms Used Incorrectly.

The terms *vaccine* and *serum* are very often used incorrectly, but a consideration of the foregoing explanations will show that the two are quite different. To summarize, a vaccine or the process of vaccination will induce an animal to manufacture its own antibodies against a disease so as to give an effective protection which will last for months or perhaps years, its efficiency depending upon the method practised and its effectiveness in any particular disease. Nevertheless an immunity so induced takes some time to develop within the vaccinated animal. Vaccines are composed of the actual germs of the disease with their toxins, the bacteria being either living and of reduced virulence, or dead. On the other hand a serum contains the antibodies against a particular disease already developed and the protection given to an animal injected with serum is immediate but much more temporary than that resulting from vaccination. The particular value of serum lies in its ability to protect at once so that by its means the spread of infectious disease can be stopped almost at once and it can be used to treat animals which have already contracted the condition.

It must not be thought that all infectious diseases at the present time can be prevented by vaccination or the use of serum. Also, the method of immunization which is successful in one disease may be quite useless in another. Moreover there are some infectious conditions wherein actual infection with the disease itself does not seem to result in any appreciable immunity and it is therefore unlikely that vaccination would have this effect.

BOVINE CONTAGIOUS ABORTION AND TRICHOMONAS DISEASE

Here two important diseases which affect reproduction in cows are described. The first, contagious abortion, is of common occurrence and the second, Trichomonas *disease, fortunately, is more rare. Contagious abortion is dealt with in some detail; its effect upon the cow, how it can be identified and how it can be controlled, are explained and the mechanism of the well-known blood test is described.* Trichomonas *disease, a venereal disease, may arrest all reproduction in a herd; its symptoms are discussed and the curative and control measures which must be applied are stressed.*

(i)

As a disease of dairy cattle contagious abortion must rank very highly among those which involve herd owners in serious financial loss. It is very prevalent in Great Britain and other countries and has been with us for very many years. To mention a few of the circumstances which follow its introduction into a herd there are loss of calves born prematurely, loss of milk from cows which have aborted and, in cases where a herd is in process of being " graded up," the loss of heifer calves may disrupt the whole scheme. As a consequence of this, mediocre animals may have to be retained in the herd to preserve the supply of incoming heifers and stock may even have to be purchased, a procedure which always has its attendant risk of introducing fresh disease.

Extremely Infectious.

Contagious abortion is caused by a bacterium called *Brucella abortus* and it is an extremely infectious disease. It can spread very readily from one animal to another and such spread may have been quite extensive before the disease is definitely identified. Since there is no treatment or cure for the disease in the individual animal, a great deal of damge may have been done before measures are started to stop the infection spreading. Its direct effect on the general health of an infected cow is negligible and the seriousness of the condition depends on the circumstances which have been mentioned, along with certain breeding troubles which may follow.

Public Health.

One other factor connected with this disease which has some bearing on its importance is the public health aspect. This has not assumed proportions of any size but nevertheless it exists and certain persons who have consumed milk containing living abortion bacteria have contracted a disease known as undulant fever. Most of us must have partaken of considerable numbers of these bacteria at some time or other and very few have been affected with this troublesome disease, therefore most people must have considerable resistance to it.

Loss of Calves.

Many herd owners must have asked themselves why this particular disease should so often take the form of causing the death and premature birth of calves. In order to understand the reason for this it is necessary to have some knowledge of how the disease is produced and to refer to structures in the pregnant womb of the cow which have already been described. The cotyledons are attacked by the contagious abortion bacterium and death of the whole or parts of these structures is brought about. This means that the supply of oxygen and nourishment to the calf is interfered with and if the interference is to a sufficient degree, as it usually is, the calf will die. If however, damage to the cotyledons is not extensive the calf may remain alive, the cow may carry it to the normal calving date and a living and apparently healthy calf will be born. It is simple to understand why a calf should die before birth when the mother is infected with contagious abortion, but why the calf should be born prematurely is difficult to understand. In the case of other diseases where calves have died in the uterus they are often carried until full time and indeed they are not uncommonly born much later; sometimes they have to be taken away by the veterinary surgeon.

Now when should the dairy farmer suspect the presence of contagious abortion in his herd and how can he be certain that it is present? All premature calvings are not the result of infectious disease and single cases of abortion can be caused by such things as falls, injury, and long journeys by road or rail, and indeed sometimes the actual cause cannot be ascertained. Be that as it may, contagious abortion is such a serious disease that it is always advisable to find out for certain whether or not it is present even if only one animal has aborted. Only the veterinary surgeon can give a completely reliable decision on this matter, usually with the help of laboratory tests. Practically the only symptom of the disease is premature calving, and this usually occurs in this disease after the cow has been pregnant for six or seven months, but it may occur at almost any time in the pregnancy although very early abortions are unusual in this disease. The experienced cowman may suspect strongly the presence of the condition, perhaps because of the appearance and sickly smell of the afterbirth or the type of discharge which follows calving. If the dead calf is sent to a laboratory the germ of the disease can be identified in it but the simplest method of diagnosis is to have the veterinary surgeon take a sample of the cow's blood for examination.

Examination of Blood.

At the present time contagious abortion of

cattle is the only common animal disease in which complete reliance is placed upon the examination of blood (that is, the blood test) for identification of the condition. Therefore, it will not be out of place at this point to give some description of the test as it is carried out in the laboratory.

Agglutination Test.

It has already been explained how antibodies appear in the blood stream as a result of infection with particular disease germs and that these antibodies have effect only on the species of bacteria which stimulated their production. It was also pointed out that if particular antibodies could be demonstrated in the animal it was certain that the germs causing them had been present in the animal at some time and to some extent at least. Therefore, if in a cow's blood antibodies can be identified which have effect on the germs of contagious abortion it means that that animal has, or has had, contagious abortion. Now, certain antibodies have the effect of causing the bacteria to clump together, that is, to agglutinate, therefore the test carried out on blood which demonstrates the presence of these antibodies is called the blood agglutination test. This is the test which is used to diagnose contagious abortion.

In the laboratory the serum, the fluid part, is separated from the remainder of the blood sample. This serum will contain any antibodies which may be present. It is mixed with large numbers of abortion germs and if it can be shown that the serum has the property in sufficient strength of making the bacteria clump together then the cow from which the blood sample came has contagious abortion; that is, the test is positive.

The blood test for contagious abortion, if positive is never wrong. Very occasionally however, if it is negative, it may give a false result for the following reason. The reader will remember that antibodies take some time to make their appearance in the body after an animal becomes infected with a particular disease. This being so, if a blood sample be taken within a few days of an animal having contracted the disease, antibodies, including agglutinins, will not have had time to appear and so the test will be returned as negative although contagious abortion is actually present. A second test, however, carried out approximately fourteen days later, would give a different result.

Method of Infection.

Having considered how this disease affects the cow and how it can be identified, let us examine the means by which the bacteria spread from animal to animal. When an abortion takes place, or if an infected cow calves at the normal time, the microbes are present in enormous numbers in the afterbirth and in the discharges which precede, accompany and follow the act of calving. A dead calf will contain many of the germs and numbers will be passed out in the cow's milk for a considerable period. It is at this time that an infected cow is extremely dangerous to other susceptible animals, and it will be realized how readily the infection can spread if an abortion takes place in the cowshed, or an infected cow calves there. The cow will swish its tail and droplets of discharge will be spread in all directions; the animal will surely be handled by workers who can transmit the germs on their hands or by means of brushes, washing cloths and other things used. If at pasture, other animals, always inquisitive when another cow calves, will approach her and sniff at the discharges. Apart from all this there is the milk which will still be passing out germs after other sources of infection have dried up or disappeared.

Routes of Infection.

It is commonly supposed that the bacteria enter the body by the mouth, being taken up in food or water. This may be so in certain cases but there is evidence to support the opinion that other routes of infection may be more likely. When the disease is intentionally given to cows or heifers, for the purpose of experiment, it is necessary to give them very large doses of the germ by mouth to be reasonably certain that they will contract the condition—doses much larger than any animal would be likely to receive under natural circumstances. On the other hand it has been shown that the disease is very readily transmitted by introducing into the eye of a suceptible animal one drop of fluid containing a moderate number of bacteria. Also, other parts of the body have been shown to be likely portals of entry for the microbe. Again, when it is realized that the germ of abortion is present in the milk of infected cows for long periods another probable method of spread suggests itself. Under such circumstances the teat cups of milking machines and the hands of milkers are certain to carry the organisms. Cows' teats always have a certain number of small sores or abrasions on them and what is more likely than that the microbe can enter the body there—particularly since it has the reputation of being able to penetrate the unbroken skin?

Control.

The ease and rapidity with which this disease can spread will have been appreciated by the reader but fortunately there are measures which, if conscientiously carried out, will stop its ravages and bring it under control. Two methods are available, one difficult of accomplishment and therefore not readily to be recommended, the other much more simple and remarkably successful.

At one time the former of these methods was the only one known. It consists of eradicating contagious abortion by identifying all infected animals as a result of the regular application of blood test. Reactors are isolated as completely

as possible and gradually eliminated from the herd. All cows and heifers are calved down in isolation and not returned to the main herd until they have passed a blood test. It cannot be emphasized too strongly that to bring this eradication method to successful completion much patience and stringent application are required on the part of the herd owner and his workers. Only under the most ideal circumstances can it be done. Most people that have tried it have fallen by the wayside.

The second method is prevention by vaccination, the modern vaccine consisting of living abortion germs of reduced virulence. However, this type of vaccine has not always been used and the development of vaccination in this disease is worthy of description in some detail.

Unique Control.

To begin with, it has been found that, in contagious abortion, any known vaccine composed of killed bacteria is valueless for protecting susceptible animals. However it has been found that the disease can be controlled by using a vaccine composed of *living fully virulent bacteria.* This was unique in the control of animal disease and its success depended on the following facts.

It has been known ever since bovine contagious abortion was adequately studied that not all infected cows abort, but that some carry their calves to full time. It is known also that most cows abort only once and that subsequent calving are normal, although the animal still remains infected and a danger to others. Some cows will abort twice, of course, a few three times and very occasionally an animal will go on calving prematurely. However, after one abortion most animals attain a state of sufficient immunity to calve normally on future occasions. It has also been found that whether an infected cow will abort or not after first contracting the disease depends, to some extent, on when she received the infection and how much of it she received. If an animal should contract a moderate dose of the infection *when she is not in calf* there is a great likelihood that she will carry her calf to full time. She will be an infected cow nevertheless.

Now, in the unique method of vaccination which has been mentioned, advantage was taken of the facts just stated. A moderate dose of vaccine composed of living virulent abortion germs when injected into a non-pregnant animal gave that animal the disease but in such a way that she was not likely to abort her next calf or any subsequent calf. Thus the outstanding and most serious symptom of contagious abortion was largely eliminated. This method had the disadvantage of keeping the disease going in a herd and it could be recommended only in herds where the condition already existed.

Modern Method.

The modern method of vaccination, already mentioned, comprises the use of a vaccine composed of living germs of reduced virulence. If a non-pregnant animal is vaccinated with such a vaccine the bacteria are unable to persist in the body for any length of time and so the vaccinated animal does not contract contagious abortion and she cannot infect others. Nevertheless, as a result of vaccination she acquires a considerable degree of immunity.

Two Vaccines.

For some time two vaccines of this nature were in general use and were made at the veterinary laboratory of the Ministry of Agriculture and Fisheries. That known as No. 1 had origin in America whereas No. 2 was first produced in this country. At the time of writing however vaccine No. 1 only may be used in herds which are producing milk designated as coming from tuberculin tested (T.T.) cows. The use of No. 2 vaccine has been suspended in such herds owing to the fact that certain experiments have indicated that No. 2 vaccine may persist in the animal until calving time, may have increased in virulence during its sojourn in the cow and may thus possibly be a danger to other susceptible animals. Nevertheless very many herd owners have witnessed the bringing of contagious abortion under complete control by the use of No. 2 vaccine and no untoward circumstances have accompanied its use.

Vaccination of Calves.

In the prevention of contagious abortion the vaccination of adult animals is now being largely superseded or augmented by the vaccination of calves. Experience in America has shown that calves so protected have a resistance to the disease which will last at least until the end of their second pregnancy. This method has many advantages; calves are easily handled and they can be vaccinated in batches and such animals are protected from the moment, later in life, that they become susceptible to the disease. Vaccine No. 1 is used for calfhood vaccination and this, unlike vaccine No. 2, when used in adults, causes the vaccinated animal to fail to pass the blood test. Vaccinated calves however have got rid of the positive blood reaction before they enter the main herd. Calfhood vaccination promises well, but final judgment of its effectiveness must be postponed and submitted to the test of time.

Vaccination will not influence the course of the disease in an adult animal which has already been infected naturally. Apparent failure of vaccination in a number of individual animals, particularly within twelve months of its inception, is explainable upon the assumption that the animals which abort during that period had already contracted the disease *before* they were vaccinated. Again, in no case can control by vaccination be guaranteed to be one hundred per cent efficient. An unusually heavy dose of the

virulent germ naturally received may break down the protection resulting from vaccination. This however does not happen frequently.

(ii)

Trichomonas Disease.

There is one very serious disease which affects reproduction in dairy cattle which had not been identified in this country until about twenty years ago. It is known as *Trichomonas* disease or trichomoniasis. There is no common name for the condition. It is caused, not by a bacterium, but by one of the minute *animal* parasites or Protozoa. It affects both bulls and cows and is a true venereal disease since it attacks the sexual organs and transmission from one animal to another occurs only during the act of mating. The bull very often is not visibly affected in any way but once infected he harbours the parasite in his reproductive organs and remains a permanent source of danger to cows. When he contracts the disease at first he may show a discharge from the region of the penis. The cow on the other hand contracts a trouble of a very serious nature, as will be seen in the following description of the condition.

If a cow becomes infected but at the same time "holds to the bull," that is, conceives, she will probably abort her calf between the sixth and sixteenth week after service; it may be aborted even earlier than this. Further attempts to breed from this animal will usually prove futile, at least for some considerable time to come. In other cases an affected cow will come into season again at six, nine or twelve weeks after the service from which had been thought that she was in calf. In rare cases she may take the bull again after three weeks. The possibility here of course is that some of these animals have aborted and that the tiny calf has not been found on the pasture or has been swept away unnoticed with dung in the cow shed. These animals again will not "hold to the bull" at future services. A fairly common symptom also is a number of animals showing a discharge from the vulva a few days after bulling and of course failing to conceive. In some cases also a cow may appear to be normally in calf up up to as long as four months after having been to the bull and then a discharge will appear.

Symptoms may Vary.

Although the foregoing is a picture of what may happen when the disease becomes active in a herd it must be realized that the symptoms may vary to a very considerable extent. It is possible for trichomoniasis and contagious abortion to be present in a herd at one and the same time and the latter disease may be blamed for all the trouble. Again, infection of the uterus with bacteria may occur in animals already affected with *Trichomonas* disease and the discharge, instead of being clear, will contain white pus. When an ever-increasing number of animals are returning to the bull or where early abortions are found, it is well to suspect trichomoniasis. If the disease is not present no harm will have been done; if it is, however, measures of control can be adopted without further delay.

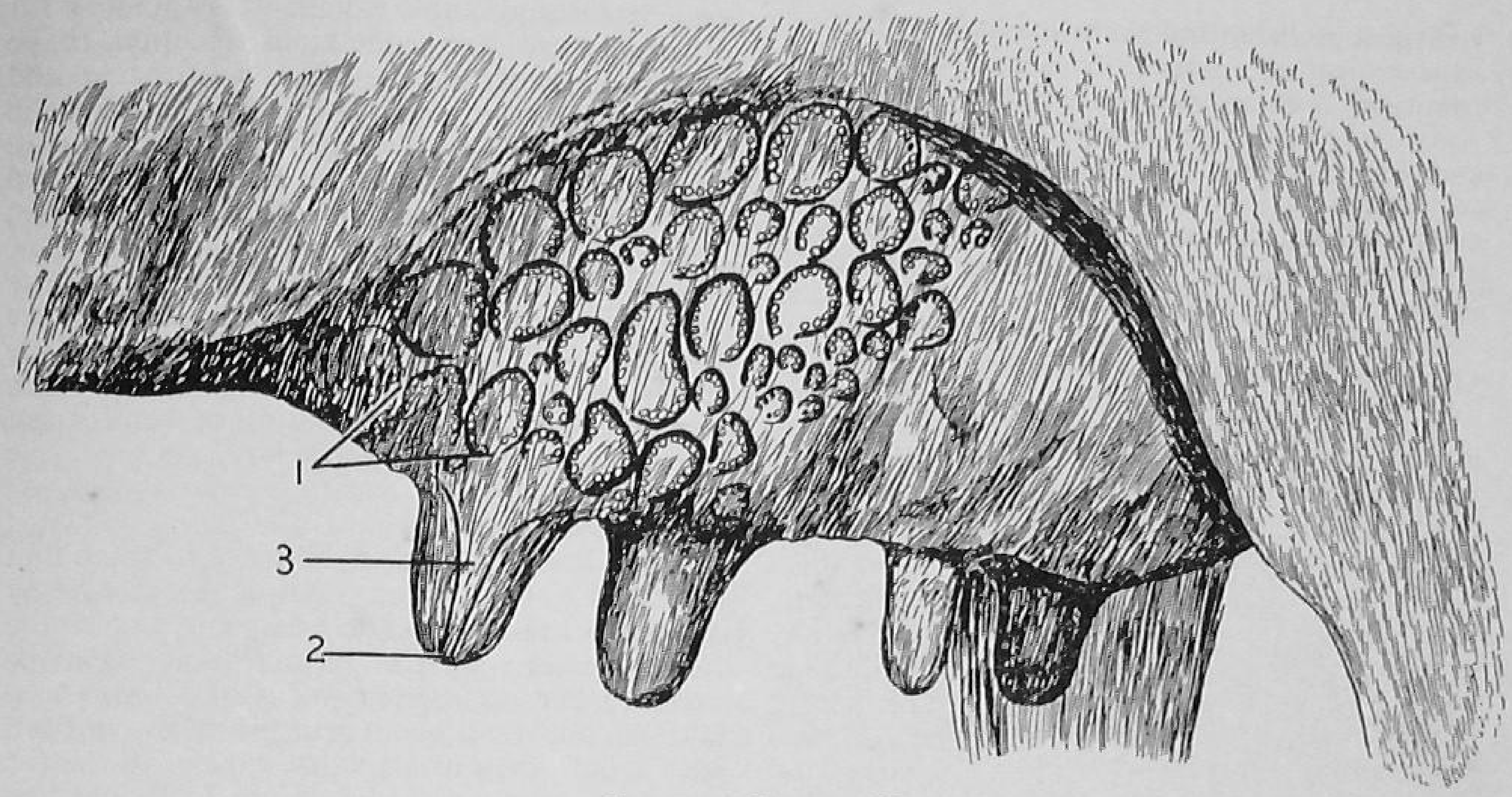
Appropriate Treatment.

There is a great deal of evidence to show that cows and heifers can be cured of this disease by application of appropriate treatment; not so the bull however. In the meantime it must be accepted that *an infected bull must be got rid of* and of course, no one worth his salt would sell such a bull, even to his worst enemy, to use for breeding purposes. The animal should be butchered and a new bull obtained. There is no way of determining when a cow is cured except that she should conceive and carry her calf successfully. If a supposedly cured animal should be mated naturally and if cure has not been complete, then the new bull will probably contract the disease.

Trichomoniasis is one disease in the treatment of which the use of artificial insemination is absolutely essential. All adult female animals in the herd should receive a course of treatment and then artificial insemination should be carried out. Those that fail to conceive should be treated again. Natural mating should not be permitted in an infected herd until a very considerable time after the apparent cure of all animals has been effected.

Considerable Losses.

The reader will realize that *Trichomonas* disease may involve the owner of an infected herd in very considerable losses: loss of calves, loss of milk, probably the cost of purchasing a new bull and the outlay involved in the application of a long course of veterinary treatment. Where a herd is extensively infected the owner must consider the economics of the situation and decide whether it would not be better in the end to butcher the adult herd and start afresh. Of course where valuable breeding animals are involved there will be only one answer to this question.



STRUCTURE OF THE UDDER
1. Milk-forming spaces or glands. 2. Circular muscle. 3. Milk channel.

THE UDDER AND MASTITIS

Udder disease, the most important ailment of dairy cows is dealt with here. A description of the structure of the udder is given and how disease affects it is explained. Then the various types of mastitis are described leading up to a detailed account of contagious or streptococcal mastitis. Most aspects of this condition are discussed—the cause, treatment and possible factors which influence its prevalence are noted. The progress of research is outlined and the author gives his views on the problem.

(i)

Inflammation.

DISEASE of the udder, or mammary gland is called mastitis or, more rarely, mammitis. Both terms simply mean inflammation of this milk-producing organ, whatever may be the cause. However, in order to understand the effects of udder disease, how it should alter the quality and quantity of milk, we must first know something of the structure of this all important gland; important because the supply of domestic animals useful to man is largely dependent on their powers of reproducing themselves. Since the young cannot be reared without milk this organ of the body is of the utmost importance. Of course, in dairy cows an animal's value depends entirely upon her ability to produce milk and to rear calves.

The Udder.

The udder of all female animals is constructed and functions in the same way although there may be differences in such details as in the numbers of teats present in the different species or in the numbers of holes or orifices present in the points of the teats. However, milk is produced in the same way in all animals and so the udder of the cow only will be described here.

The mass of the udder substance is composed of tiny spaces, each space being lined by a layer of cells. Blood vessels mingle intimately with these cells and supply to them the material for the manufacture of milk, a function carried out by the cells alone. Between the spaces are layers of a tough tissue which serve to support the cells, to hold them in position and which form a supporting framework for the whole udder. Round each space also is a thin layer of muscle which, when it contracts, squeezes out the milk which has been formed by the cells. Each space is drained by a minute channel or duct into which the milk passes. Ducts from a number of spaces join together to form larger ducts. These in turn join with others, all passing downwards towards the teats. Further junctions of ducts take place until quite large ones are formed and these terminate in fairly large spaces, one of which is situated directly above, and is drained by, each teat.

Normally, in the cow's udder there are four teats and each has a central channel, the teat canal. At the point of each teat and at the lower ends of the teat canals there are circular rings of muscle round the outlets which, when contracted close the outlets and prevent escape of milk. When the cow is being suckled or milked these tiny muscles relax and allow milk to flow.

Four Quarters.

The cow's udder is divided into four quarters,

each quarter being drained by one teat. The two quarters on the same side are divided by a partition from the two on the other side but no such division exists between the two front quarters and the two hind; nevertheless they are not connected. Therefore, the milk of one quarter does not mix with that of another and disease affecting one cannot normally extend directly into another.

Milk.

It has been stated that the cells lining the very numerous tiny spaces in the udder produce milk. Milk then passes through the channels or ducts, collects in the spaces above the teats and finally emerges from the teats. When a cow is ready for milking milk occupies all parts of the udder, spaces, ducts and even the teats themselves. As milking or suckling proceeds, milk is continually forced downwards towards the teats this being brought about by the action of the small muscles already described. This " letting down of milk " as it is called is an act over which the cow has no conscious control and one which will not let her milk down is not being voluntarily stubborn as many seem to think. Any upset to the cow, even such as a stranger in the cow shed at milking time, will probably have the effect of making a number of cows hold their milk. They cannot help it however.

Disease.

When disease attacks the udder it almost always ascends from the teat, if it has gained entry in that way, and involves the milk producing cells to some extent at least. Again, if disease extends to the udder from some other part of the body or if it commences from an injury to the wall of the gland the cells will be attacked almost at once. Hence, alteration in the composition and quantity of milk is a constant symptom of mastitis. The milk cells of the udder, when destroyed by disease, are never replaced and even though recovery takes place a lowered yield of milk usually results.

In some forms of mastitis complete destruction of all milk cells takes place and the affected quarter is irretrievably lost. In other cases, particularly in the more chronic forms of mastitis, part only of a quarter may be involved, at least to begin with. The udder reacts to the constant slow working irritation and in the region of the diseased part a tough hard tissue is formed, fibrous tissue, which can be felt plainly in many udders affected with chronic mastitis. Probably this formation of fibrous tissue is an attempt on the part of the body to arrest the progress of the disease. In tuberculosis for instance this can and does happen, but in chronic mastitis the infection is almost always slowly progressive and in the absence of effective treatment will eventually destroy the affected quarter.

Immediate Cause.

In all cases of mastitis the actual and immediate cause of the condition is infection of the udder with some particular type of bacterium. One species of germ brings about one form of mastitis and no other, therefore udder inflammation at the present time is named and classified according to the type of microbe causing the disease. Thus we have tuberculous mastitis when the tuberculosis germ is involved, staphylococcal mastitis when staphylococci are the cause and streptococcal mastitis when the infecting organism is a streptococcus. One exception to this is called summer mastitis where the culprit is a germ which rejoices in the name of *Corynebacterium pyogenes*. Even so, the term pyogenes mastitis is coming into use.

Tuberculous Mastitis.

Tuberculous mastitis is not of serious economic importance to the dairy farmer since losses of cows from this condition are comparatively small. Even in cows affected with tuberculosis elsewhere in the body involvement of the udder is not so very common. There is some recent evidence to show however that tuberculous udder infections of such animals is rather more frequent than is generally supposed.

The real importance of tuberculous mastitis lies in the fact that an infected udder can pass out milk which contains numbers of the tuberculosis germs. Such milk is dangerous to humans, principally children, in that it can set up the disease in them, particularly in bones and joints and in the abdominal region. It is from this point of view that eradication of tuberculosis from dairy stock is so very important. Any cow which can be definitely shown to have tuberculosis of the udder is slaughtered immediately but the fact always remains that she probably had been passing out the germs in her milk for some time before the disease was detected. Even allowing for the protection given to consumers by the heat-treatment of milk—that is, pasteurization—it would seem that the only reliable means of preventing such human infections is to eliminate the disease from dairy cows. Effective pasteurization is dependent entirely on human endeavour and therefore is subject to error. As an interim measure however it is to be recommended with respect to milk that comes from herds not known to be free of tuberculosis.

The effect of the germ of tuberculosis upon the udder is similar to its effects on other parts of the body, described elsewhere in this book. The disease is slowly progressive and the affected quarter becomes hard and lumpy due to the formation of fibrous tissue.

Staphylococcal Mastitis.

Staphylococcal mastitis is frequently an extremely acute condition; it may even kill the affected cow by reason of invasion of the whole

body by the germ or because of absorption, into the system, of toxins produced in the diseased udder. In such cases the affected quarter is involved as a whole; it is hot, swollen and painful. The teat also is extremely swollen and the discharge which can be drawn from it consists of thick pus. In all cases of such acute udder disease the cow becomes very ill. It is extremely important that discharge should be drawn away from affected quarters as frequently as possible and hot fomentations will help to ease the pain. Nowadays an injection can be given by the veterinary surgeon which will combat the general effects of the disease and probably save the cow's life. However, in acute staphylococcal mastitis, an affected quarter never produces milk again even although the disease subsides. Destruction of the milk producing cells has been complete. In certain cases of this type of udder disease the already diseased quarter is invaded by a further type of germ, one of the sporulating anaerobes. The result is that death and putrefaction of the parts attacked occurs; the quarter becomes cold and black and quite often part of it becomes separated from the rest of the gland and drops off. It is wonderful how cows may sometimes recover and live after such a happening.

A chronic, much less severe type of staphylococcal mastitis is becoming increasingly recognized. This resembles very closely in its effects the chronic form of streptococcal mastitis yet to be described. The milk is but slightly altered in the early stages, but the yield becomes gradually less and less and the condition slowly becomes worse. This type of the disease seems to show some disposition to spread from cow to cow whereas the acute form does not as a rule.

Unfortunately at the present time no drug has been discovered which can be relied upon to act against staphylococci and so cure this form of mastitis.

Summer Mastitis.

Summer mastitis is always an extremely acute condition and it is reputed to affect dry cows and heifers when at grass. However the writer has encountered a not inconsiderable number of cases of mastitis caused by *Corynebacterium pyogenes* in cows which are in full milk, in winter as well as in summer.

Perhaps this outstanding feature of this form of the disease is the foul smell of the pus or discharge which can be drawn off from the affected quarter. The quarter and teat are hard, painful and swollen, the teat standing out from the quarter in an unusual way even at a very early stage of the condition. Sometimes this is the first symptom that is noticed. The infected quarter is invariable lost and sometimes the cow herself dies for reasons already described under staphylococcal mastitis. Again an injection may be given to counteract the general effects of the disease and the udder itself is treated by frequent stripping, massage and hot fomentations. On occasion, the discharge is so thick that it is necessary to have the teat amputated to allow the pus to drain away.

(ii)

Of the types of mastitis already mentioned one still remains which, because of its great prevalence in dairy herds and by reason of the economic losses involved when the disease is active in a herd, is by far the most important. So much so in fact that it will be dealt with more fully.

Streptococcal Mastitis.

This form of mastitis, streptococcal mastitis, contagious mastitis, garget or weed may assume any one of a number of forms but all are manifestations of one and the same disease. The germ causing the condition is known as *Streptococcus agalactiae* and numbers of these microbes can be found in the milk of cows which are affected. As far as is known, however, and a good deal *is* known, these streptococci are harmless to human beings.

Mildest Form.

In the mildest form of this disease, and in the early stages, all that will be noticed are a few clots in the milk, particularly at the beginning of milking. Even before this, it is possible that a slight but progressive drop in the animal's yield of milk may have been noted. Before long the experienced cowman will be able to detect a change in the substance of the udder when he handles it. A slight " thickening " will be evident. This state of affairs may go on for some considerable time and may apparently clear up on occasion. However, as a rule the disease is progressive; changes in the milk become more extensive, clots more frequent and greater in quantity until, at length, perhaps months later, normal milk will not be given and only a clear or straw-coloured fluid containing many clots will be yielded. At the same time the affected quarter will have become progressively hardened, shrunken and probably distorted. This is an example of how streptococcal udder disease develops if it remains chronic throughout.

" Chill."

In other instances an affected quarter becomes swollen, red and often quite painful but as a rule the cow's general health remains unaffected. This type of the disease is often called " chill " of the udder and, while chilling may have had something to do with it, as will be seen later, the bacteria are the actual cause. This, the acute form of streptococcal mastitis, quite commonly follows calving and may be temporary in character. The affected quarter may clear up without treatment and the milk, which has been grossly altered, return to normal. Nevertheless it is probable that a

decrease in yield will have resulted. Some cows show a disposition to be affected with this form of attack and suffer repeatedly from it.

Third Type.

A third type of the disease may be encountered wherein the quarter is but slightly swollen and little pain is felt on handling. The milk undergoes some change and the affection may clear up or become chronic.

It is quite possible for one form of streptococcal mastitis to merge into another. One or more acute attacks may precede the development of the chronic form or an acute outbreak may be superimposed on chronic disease. Although the disease may sometimes apparently disappear spontaneously for a time more trouble is usually experienced again later. It is not likely that this will constitute a new infection with the germ; it is very probably a continuation of the previous attack, the disease having been dormant for some time.

Veterinary Treatment.

With respect to the veterinary treatment of streptococcal mastitis in cows it can be said with justification that a fair degree of success has been attained. It cannot be emphasized too strongly however that early treatment is essential if the maximum effect is to be obtained. It is useless to expect any form of treatment to have much effect on a quarter the milk producing tissue of which has undergone considerable destruction.

Sulphanilamide.

The well-known drug sulphanilamide has proved very effective in many cases particularly in acute attacks. The other common form of treatment is injection or infusion of the udder with various fluids which attack the streptococcus. This is usually done when the animal is not in milk and is most effective in the early stages of the chronic form of the disease.

The Solution.

Apart from treatment, the eradication and also the control of streptococcal mastitis in dairy herds has been the subject of much investigation during the past twenty years or so. Research workers have devoted more time to this than to any other one animal disease and if results have not been all that we could wish for, the researchers cannot be blamed. Indeed the discoveries which have been made, while promoting a better understanding of the disease, have, at the same time demonstrated the extreme difficulty of achieving a solution. On occasion, critical comments have been published in the farming press wherein much has been written regarding the need for intensive research into the means of preventing mastitis in dairy cows. The attitude has been taken up that no adequate efforts had been made to solve the problem. It is almost certain that those who think in this way have not had an opportunity to gain an insight into the true nature of the disease. One thing that research has shown is that the solution may lie as much in the hands of the herd owner and his workers as in the efforts of veterinary surgeons.

General Hygiene.

When it was first established that the true cause of streptococcal mastitis was a particular germ and that it entered the udder via the teats, being carried on washing cloths, milkers' hands and the teat cups of milking machines, a method of control presented itself for investigation. It was decided that, if all infected cows in a herd could be detected and if measures could be adopted to prevent the spread of the organism to non-infected cows, the disease could be checked. Consequently measures of isolation of infected cows, disinfection and general hygiene were introduced into cowsheds with this end in view. Infected cows were isolated from the others and milked last, or failing the possibility of complete isolation, they were placed together at one end of the shed and handled, washed and milked last. Also hypochlorite disinfectant solution was used for washing the udders prior to milking, care being taken that the disinfectant was changed sufficiently frequently and that the washing cloths remained for a sufficient time in the disinfectant to kill the germs between the washing of individual cows. Also, attempt was made to disinfect the hands of milkers in a similar way between milking individual cows; moreover, teat cups of milking machines were given the same sort of treatment.

Complete Control.

At the outset these measures seemed to have some beneficial effect and indeed in a number of herds complete eradication of this mastitis organism seems to have been achieved. There is evidence that complete control of the disease *can* be obtained by the application of such methods but *they must be applied stringently, conscientiously and constantly to have any hope of success.* Herein lies the difficulty. In the ordinary commercial herd the time factor is very important in the milking routine and so workers are apt to overlook details, particularly when time is short. That, in the author's opinion, makes these means of controlling streptococcal mastitis impracticable in the majority of cowsheds. Furthermore, the extreme difficulty of restricting the spread of the *streptococcus*—along with other aspects of the disease—has come to light and these facts make it understandable why so many failed to arrest or restrict the course of the disease in a herd by the application of the methods advocated. Indeed it is surprising that complete success could have been achieved at all.

It has been proved now that some cows may harbour the germ of streptococcal mastitis in their udders for lengthy periods without their

showing any sign of udder disease. Also, the microbe may be found in the milk of certain animals for a time; then it may disappear, again without mastitis developing. Some few cows in infected herds, although their milk has been examined weekly over long periods, may never show any sign of the infection in the milk. However, perhaps the most significant result of recent research is the discovery that, in infected herds (and there are many such) the udders and the skins of the teats of almost all cows will harbour the mastitis organism at some time or other. It has not been shown that the spread of the germ *cannot* be prevented by the use of disinfectants and rearranging of the milking order; however, the inference is that in most commercial herds the spread is not completely prevented even when such methods are in use.

The obvious conclusion from the research described is that most cows must be able to resist the effects of the germ of streptococcal mastitis for long periods, perhaps for life and that some circumstances must be present which, at times, upset this resistance and make the udder susceptible to the germ. These circumstances or predisposing causes, are mostly the subject of conjecture at the moment although one or two would seem to be definitely established. All who are familiar with cows will know how frequently udder disease follows injury to a teat or to a quarter. Here the probability is that the germ was already present in the udder and that the injury had lowered the resistance to its effects. Again, mastitis frequently follows the act of calving, presumable when the animal's vitality lowered so that resistance to udder disease is lessened. Again, it is almost certain that chilling of the udder will bring about an attack of mastitis. Chill of itself never caused any disease, it only lowers body resistance to disease germs.

Many Circumstances.

It will be an extremely difficult matter to determine all the predisposing factors which may bring about mastitis; in fact it seems an insuperable problem because so many circumstances may be involved in this respect. Is it not possible that the modern dairy cow, having been bred for very many years to produce more and yet more milk, is now the possessor of an udder which is overworked and consequently more susceptible to disease? Cows may be on the border line of susceptibility and it is possible that even minor factors may influence resistance and small adverse circumstances tip the scales in favour of the germ. Many such factors have been suggested. There is the possibility that the prolonged contact of the udder with the cold, often wet, concrete floors of stalls will bring about chilling. Again, the advent of milking machines has been blamed for increasing the number of cases of mastitis but the author has seen just as severe outbreaks in hand-milked herds as in any that were machine-milked. Nevertheless there seems to be little doubt that milking machines can predispose to mastitis when mis-managed, for example, when run at too high a vacuum pressure, too fast a pulsation rate or when left on the cows too long. It is probable too that a change from hand to machine-milking may cause a flare-up of mastitis; in such a case the disease outbreak will most likely be due, not so much to the machine itself as to the change, and things should settle down quite comfortably once cows have become accustomed to the machine.

Other Factors.

Other factors which have been suggested as influencing a cow's susceptibility or resistance to mastitis include heredity, feeding a ration of high protein value, differences in udder and teat conformations, rough handling of animals, washing the udder with cold water. Evidence is lacking that any one of these has much influence on mastitis but this does not mean that they can be overlooked as possible predisposing factors.

The reader will appreciate that one of the most important factors governing the occurrence of streptococcal mastitis is the relative susceptibility or resistance of the cow and that what the factors are which influence resistance are not yet understood. In all probability, indeed it is almost certain, that management may play a most important part but in most cases it is extremely difficult to detect wherein lie the errors of management. It may be that some of the measures adopted to produce maximum quantities of clean milk are not the best from the point of view of the cow. A cow deeply bedded in straw which may be contaminated with an accumulation of dung may not be in the best position for the production of clean milk but at least she will be warm. Possibly in our endeavours to look after ourselves we have forgotten the health of the cow.

Three possibilities seem to present themselves as possible means of overcoming this scourge of the dairy herd. One is the identification and elimination of the predisposing factors, the second is the discovery of methods of treatment which will result in one hundred per cent cure and the third is the development of a simple routine of the cow-shed including the use of an adequate cleansing agent and disinfectant to eliminate the spread of the germ from cow to cow. The first seems the least likely and it is possible that a combination of the other two will be developed.

In the meantime, and in most herds, all that can be done is to restrict the spread of the germ as far as possible by the methods already described and to have the disease kept in subjection by the application of early treatment. Although predisposing causes are all important the fact remains that if we could eliminate the germ from herds there would be no streptococcal mastitis and the cow's ability or inability to resist the organism would not matter.

FOOT AND MOUTH DISEASE: SWINE FEVER: SWINE ERYSIPELAS: WOODEN TONGUE: LUMPY JAW: ANTHRAX.

Here we have a group of unrelated well-known animal diseases. Foot and Mouth Disease and Swine Fever are similar in that each is caused by a virus and both are notifiable. That deadly condition, Anthrax, also falls into the same category. Wooden Tongue and Lumpy Jaw are two troublesome ailments of cattle; and Swine Erysipelas may cause serious losses in pigs. Symptoms and course are dealt with in all; and control measures are discussed.

(i)

Foot and Mouth Disease.

FOOT AND MOUTH DISEASE is probably the one animal disease which is familiar to every one, by name at least. This is not because of the relative frequency of its occurrence but by reason of the importance placed upon it by the Authorities. The presence and situation of every outbreak are recorded in the daily press and frequently broadcast on the radio as well. Very stringent measures are adopted to limit or prevent the spread of this disease and, it is notifiable.

Recognizing the Disease.

This means that, immediately an outbreak is suspected, the police must be notified and the matter is placed in the hands of the Ministry of Agriculture and Fisheries' veterinary inspectors. These men, experienced in recognizing the disease, conduct an intensive examination of all susceptible animals on the premises where the disease is suspected and decide whether foot and mouth disease is present or not. If its presence is confirmed all susceptible animals which have been in contact are killed and cremated on the spot with as little delay as possible, the owner being compensated for their loss on an agreed valuation.

" Standstill."

Apart from these drastic measures, movement of animals from place to place within, or into or out of a large area surrounding the infected premises is forbidden for a time. Even on his own land, with certain exceptions, a farmer may not move animals as he pleases if they have to cross or move along a public highway or lane. All markets and fairs in the " standstill " area are closed and all necessary measures to bring the disease under control are adopted. Restrictions are relaxed only when it is fairly certain that no further outbreaks are going to occur in the area.

The foregoing is not an attempt to outline the complete provisions of the Government Orders made to control foot and mouth disease. Certain procedures have been described in order to convey, to the lay reader in particular, the extensive disorganization of farm routine and agricultural trading which follow an outbreak.

Even among those who have no interest in farming whatsoever many arguments and discussions have taken place as to whether the restrictions imposed and the financial outlay incurred by the Government are justified. To many, the wholesale slaughter of animals, in addition to the cost to the country of compensation are quoted as being quite inexcusable and when they learn that most infected animals would recover anyway their condemnation of the procedure becomes most vehement.

Let us consider therefore what would happen if all measures governing the control of foot and mouth disease were removed forthwith.

Diseases Stamped Out.

First of all it must be understood that compulsory disease control measures have a certain justification because this country is an island. Having no common frontiers with other countries, if a disease is eradicated completely, we have an excellent opportunity to prevent its reintroduction. Rabies in dogs and glanders of horses may be quoted as examples of diseases which have been stamped out and kept out. Although this fortunate state of affairs has not come about with respect to foot and mouth disease, except for comparatively short periods, nevertheless, when more is known about the means by which infection is conveyed into the country, or if hitherto undeveloped methods of controlling the condition come into use, we may attain complete eradication.

Foot and mouth disease is a tremendously infectious condition. Apart from direct contact between animals the disease can be transmitted by almost any means; anything whatsoever that has been contaminated directly or indirectly with the germ from an infected animal can transmit it elsewhere. Birds have been blamed for carrying it for considerable distances mechanically, on their feet, and it is thought that movement of air may convey it over short distances.

It will be realized, then, that only the strictest measures will have any success in limiting the spread of this disease and surely the first procedure should be completely to destroy the infection at its source. The only way to do this is to destroy, and preferably cremate, all animals which have the disease and those which may be about to contract it by reason of their having been in contact.

Natural Questions.

Be that as it may—and it may be agreed that the procedure which is adopted is the surest method of preventing the disease spreading—why go to all this trouble and expense when affected animals will usually recover? Why not allow the disease to pursue its own course? Infected animals and their owners may suffer some inconvenience and the latter may incur some financial loss but it will

be only temporary. A considerable number of animals would be saved for future use and the taxpayer would probably benefit to some small extent.

Effects of the Malady.

Unfortunately the position is not quite so simple as this. It is true that most affected animals would recover from the disease but very few if any would recover from the effects of the malady. Affected dairy cows suffer a very considerable reduction in their yield of milk and the loss is rarely regained; beef animals and all others which have the disease lose condition very rapidly. They become lame and emaciated and both forms of disability may persist for the rest of their useful lives. The lost flesh is rarely if ever replaced and a lame animal will never thrive.

It is not outside the bounds of possibility that, if allowed to spread unrestrictedly, foot and mouth disease would ultimately affect the majority of susceptible animals in the country with consequent loss of milk and flesh. If this were allowed to happen the loss to the country and to individual owners would be many times greater than that incurred by the slaughter policy and its attendant restrictions.

Taking everything into consideration surely the procedure at present carried out for the control of foot and mouth disease is amply justified.

The Disease Itself.

Considerable space has been devoted to discussion of the foot and mouth disease control measures and in view of the general interest in this condition no apology is made for so doing. However we shall now devote our attention to consideration of the disease itself, what causes it and how it affects animals.

Filtrable Virus.

Foot and mouth disease is caused by a filtrable virus which accounts, in part, for its being so infectious. Cattle, sheep, pigs and goats are susceptible and the disease has been encountered in man as well. The infection seems to be contracted by mouth but it is thought that inhalation of the virus may set up the disease in some cases. On an average, in from three to six days after the infection is received the disease develops. There is loss of appetite at first and the temperature is raised considerably but this symptom persists only for a day or two. Then those changes occur in the feet, in the mouth, or in both, which give the name to the condition.

Small eruptions like water blisters appear in and around the mouth, being about one quarter of an inch in diameter and may reach the size of about two inches when they develop fully. They are round in shape and when they burst a raw red surface becomes exposed. Similar blisters often appear round the tops of the hooves. In cattle, the feet and the mouth are usually both affected whereas in sheep and pigs the blisters are commonly found in the region of the feet only.

Considerable Pain Suffered.

Considerable pain is suffered by affected animals, lameness usually develops, because of pain in the feet, and animals may refuse to rise. The horn of one or more hooves may come away completely leaving a raw sensitive surface. Dribbling of saliva and difficulty in eating are found when the mouth is affected. As the pain becomes more severe animals will refuse to eat at all. In cows, the udder occasionally is attacked, blisters appearing on the teats and elsewhere.

If the disease be allowed to run its course animals affected with foot and mouth disease will have recovered usually in from two to three weeks and a herd will be clear in five or six weeks. As has been said, however, after-effects last for a very considerable time; but spontaneous recovery is never permitted in this country and retention of the animals for treatment is not allowed.

No successful method of vaccination against foot and mouth disease has yet been devised and until prevention by this means proves to be a practicable possibility it is unlikely that there will be any alteration in the existing methods of dealing with the disease.

(ii)

Swine Fever.

Swine Fever is an infectious notifiable disease which affects pigs only and it is found in all parts of the world where these animals are kept in captivity. For many years great confusion existed in the identification of disease of swine and it is only within the past fifty years or so that considerable advances have been made in the knowledge of pig ailments. It has become recognized that certain pig diseases which resemble swine fever in their general symptoms have no connection with that disease whatsoever and that true swine fever can be masked by the fact that bacteria can and do invade the body of the already infected pig. These bacteria, although having no connection with the actual cause of the condition, may bring about certain complicating symptoms such as pneumonia or enteritis.

Cause of Swine Fever.

It is now universally accepted that the cause of swine fever is a filtrable virus and that this can be found in the urine and dung and in any other body discharges of infected pigs, apart from its being present in the blood. A characteristic is the rapidity with which it may spread through a herd of pigs, a fact which is understandable when one considers how infected pigs constantly contaminate their surroundings with the virus and that it is not readily killed by heat, weathering or disinfectants.

No Definite Signs.

It is not possible to describe symptoms which might be considered to be typical of the disease. No definite signs exist which are detectable before death and which might indicate with reasonable certainty that the affection is swine fever. Animals

at first will refuse food and show a high temperature. Later they tend to lie motionless in a dark corner of the sty and can be made to move with difficulty. Weakness of the hind legs may be shown, diarrhoea may be present and some may cough. In general, the most that one can say is that the pigs are very sick. It may be noticed also that only a few are affected to begin with but soon after, development of the disease follows in others. Every pig which is affected with swine fever does not necessarily die. It is usually fatal to very young pigs and the older the pigs are, the better are they able to resist the disease.

It cannot be emphasized too strongly that the pig owner should never attempt to decide for himself whether swine fever is present or not. Indeed, being a notifiable disease he must report it on suspicion. Apart from this however, and as has been stated, there are no external symptoms which enable a definite diagnosis to be made; a post-mortem examination of a carcase is necessary. If serious illness is present among a number of pigs and if the cause is not definitely known, either a veterinary surgeon should be called at once or the police notified.

Vaccination.

At the time of writing it has been announced that an effective method of vaccination against swine fever has been developed and that the vaccine is to be issued shortly. This will induce, in vaccinated pigs, an effective immunity against the disease, an immunity which will last for approximately one year, which is longer than the life of most pigs. Presumable sows and boars which are retained for a much longer period will have to be re-vaccinated annually.

(iii)

Swine Erysipelas.

Swine erysipelas can be confused readily with swine fever and the differentiation of the two should always be left to the veterinary surgeon. It is not notifiable, but nevertheless it can cause serious losses of pigs. It has no relationship with human erysipelas.

The cause is a bacterium which has the complicated name *Erysipelothrix rhusiopathiae.* The condition is infectious and can assume a mild, an acute or a chronic form. It commonly affects fat pigs of medium age and young pigs do not as a rule contract the disease. Swine fever, it may be remembered, attacks pigs of all ages and young pigs are most susceptible.

Mild Form.

The mild form of swine erysipelas is never fatal except in cases where it becomes chronic. In this form of the disease there is dullness, which comes on quite suddenly, with high fever; the skin over certain areas of the body occasionally develops peculiar purplish areas which are sometimes rectangular or diamond-shaped. The appetite is completely lost for a day or two and swellings of the hock joints of the hind legs may appear. These symptoms then pass off and the animal recovers.

Acute Cases.

In acute cases, symptoms resembling those of the mild form are found but they develop more quickly and to a greater degree. Purple blotches on the skin, by no means always present, may cover the whole body, lameness may be very acute owing to the swellings in joints, and diarrhoea is often profuse. Death may take place any time from twenty-four hours after the onset of the condition to about ten days afterwards. Some pigs may recover, while in others the chronic type supersedes the acute form.

Chronic Disease.

Chronic disease is usually a sequel to a mild or to an acute attack. The affected animal is obviously not well, does not thrive, is disinclined to move about much and spends much of its time sitting up on its chest with the forelegs forward; it does not lie on its side as pigs do normally when resting. The purple skin discolourations are sometimes evident and the animal may cough frequently. Pigs with chronic swine erysipelas rarely recover.

In acute cases of this disease the germ is found circulating in the blood and by its presence and its poisonous effects, it produces the symptoms which have been described. In mild cases the animal's resistance is able to keep the organism in check and to overcome it completely; failing this complete recovery the germ will persist in the body to some extent and chronic disease will be established. Acute cases arise either because there is little or no resistance on the part of the animal or because the virulence of the germ is of a high order.

In chronic condition the bacterium settles in certain parts of the body. This happens often in the valves of the heart where characteristic growths develop as a consequence and these completely upset the action of the heart, leading to faulty blood circulation; consequently the pig does not thrive and as the condition progresses it dies.

Vaccination.

Pigs can be protected against swine erysipelas by vaccination and by the use of serum. As is always the case, serum imparts an immediate protection and so it can be used to prevent spread of the condition to healthy pigs, once an outbreak has commenced. The immunity arising from such administration of serum will be temporary; but if a natural infection has been received while the pig is immune, as a result of inoculation, because of infection with the living organisms, the immunity will become much more lasting. A method of conferring immunity is to inject serum and the living virulent germ together. The serum will prevent the germ establishing itself but the result will be some degree of lasting immunity.

The animal is then in a position to withstand a dose of the living organism alone. This is given some days later and the state of immunity is consequently considerably enhanced and prolonged.

(iv)

Two Diseases.

There are two diseases of cattle which may well be considered together since they have certain similarities. One, Wooden Tongue, as the name suggests, principally affects the tongue whereas the other, Lumpy Jaw is found in the lower jawbone and commonly affects one side only. Both are diseases which develop comparatively slowly and little or no body-defence seems to be set up against them. Both will progress if not treated until the affected animal has to be slaughtered. Early recognition and treatment, particularly of Wooden Tongue are essential when one first suspects either of these conditions. Lumpy Jaw, since it causes bone enlargement and deformity cannot be treated successfully from the point of view of bringing the bone back to normal. The most that can be hoped for is that the disease will be arrested before it has gone too far.

Wooden Tongue.

Wooden Tongue is technically known as actinobacillosis but the term actinomycosis is frequently and incorrectly applied to it. The germ of this disease, *Actinobacillus* most commonly attacks cattle but it may also be found in sheep. It has a tendency to settle in soft tissues such as the tongue, back of the throat and cheeks and even in certain internal organs such as the liver or lungs. In cattle however the commonest sites would appear to be the tongue and neighbouring parts.

In the tongue the first signs are raised hard pimples or nodules which gradually become larger. A chronic inflammation is set up and quite large areas of the tongue may become hard, " wooden " and distorted. The tongue literally, in later stages of the disease, becomes too large for the mouth and may protrude. In some cases affected areas may become ulcerated.

The first symptoms which are noticed as a rule are that the animal has difficulty in taking up its food. This is followed by dribbling of saliva from the mouth and difficulty in chewing. Examination of the tongue will reveal affected areas which are hard and raised. For these signs the tongue should be examined all over including the underside and root. This may be found to be a difficult procedure to one unaccustomed to it. As the disease progresses enlargement, protrusion and probably ulceration as already described will develop.

When other parts of the body are attacked by this germ different effects may be produced such as suppuration and formation of abscesses and at times the development of growths which protrude from the affected part.

Treatment.

The treatment of Wooden Tongue by the proper means is an effective remedy; but a great deal depends upon how soon it is begun after the disease develops. Also, it should be persisted with and carried beyond the point of apparent recovery otherwise the disease may recur. Although all symptoms have disappeared there is always the possibility that some living germs may still be present in the affected part if treatment has not been carried on for a sufficient length of time. In such a case the trouble will reappear. Again, if treatment is delayed until such time as the tongue is enlarged and distorted it is too much to expect any treatment to repair the damage.

When sheep are attacked by this microbe abscesses break out over the face and under the jaw. They extend down the neck and often develop in the lungs where they appear as raised, round greenish white areas which protrude from the lung surface like marbles partially embedded. If the skin and tissue beneath it on the face or neck region be squeezed between the fingers where abscesses are present worm-like strings of thick pus, like tooth paste, will be pressed out.

Affected sheep usually die. The condition is not sufficiently prevalent or well recognized for the success or otherwise of treatment to be established definitely.

Lumpy Jaw.

Lumpy Jaw or actinomycosis is caused by invasion of the lower jawbone by the germ *Actinomyces bovis*. It is first recognized in cattle by enlargement and distortion of this area. The microbe causes destruction of bone and the body's attempt at repair and replacement results in new tissue, including bone, being formed in a very irregular manner. Thus, excess bone appears and as the disease progresses great enlargement may result. The picking up and mastication of food are interfered with and if the condition reaches this stage the animal will become thin and weak.

Treatment.

As has been said, no treatment can cure this disease to the extent of reducing the bone enlargement. It is possible that, if carried out sufficiently early, treatment may prevent further extension of the condition but there can be no guarantee of this. Probably the best policy is to have the animal slaughtered while it is still in good condition and thus be sure of preventing a dead loss.

Both Wooden Tongue and Lumpy Jaw are contracted by the animal's picking up the germ while feeding or drinking. Probably each gains entrance to its favourite site by means of a minute injury of the part concerned and these microbes are good examples of the fact that certain bacteria show a great preference for particular parts of the body. The actinobacillus attacks the tongue

or other soft structures whereas actinomyces prefers bone and especially jawbone, at least in cattle.

The two diseases just described, as far as they affect cattle, show no tendency to spread from animal to animal; as a rule only isolated cases occur in a herd.

(v)

Anthrax.

Anthrax is a disease of great antiquity and it is surely the most deadly of all, at least as far as animals are concerned. Cattle, sheep, horses, pigs, and dogs, in fact, all domestic animals and man himself are susceptible. Birds are rarely if ever affected. In man it is almost wholly limited to those who, in the course of their daily work, come into contact with infected animals or animal products. Thus those who handle hides or offal may contract the disease, but it is not common.

The germs which cause anthrax are among those which have the faculty of forming spores, but the anthrax organism is not an anaerobe nor is it of the group of bacteria which cause putrefaction. Anthrax spores can remain alive in soil and other places for many years and constitute a danger to animals. The microbe, *Bacillus anthracis* is found in almost all countries and deaths from anthrax are common in the tropics. In these parts, because of the temperature, the organisms can apparently live *and multiply* in soil, and this increases the probability of an animal becoming infected. In Great Britain however any of these bacteria which are present in soil must have come from a case of the disease, for the climate is too cold for the germ to live in soil except as the spore form and spores *do not multiply*.

The Anthrax Germ.

The anthrax germ is one of the most virulent known and it commonly gains entry into the body of animals through the mouth with food or water. The spores can resist the action of digestion and the bacteria which develop from the spores very rapidly invade the body from some part of the digestive system. The rapidity with which it eventually invades the body as a whole differs with different animal species. When, however, invasion does occur the germs are present in the blood in enormous numbers and so septicaemia or blood poisoning develops. Man is usually affected by the microbes gaining entry through a skin cut or abrasion. At this point of entry a severe boil or carbuncle, known as malignant pustule, appears and if the advance of the disease is not stopped septicaemia will ensue.

In cattle and sheep, anthrax is extremely acute and pursues a very rapid and fatal course. Very commonly when last seen an animal may appear quite fit only to be found dead some hours later. Therefore, sudden death in these animals, other than from an obvious cause, must be looked upon as suspicious of anthrax, and, since it is a notifiable disease, the police must be informed. On occasion death may not supervene so quickly and in such a case great pain, very high temperature, straining and diarrhoea caused by inflammation of the intestines are found.

In the horse, pig and dog the disease is usually of longer duration than in cattle or sheep. The germ settles temporarily in the throat region and causes a large painful swelling. Just before death, however, invasion of the blood and whole body takes place. In these animals also, as in all, suspected anthrax must be notified.

When death from suspected anthrax has taken place it is an offence to cut into the carcase in any way, and so the carrying out of a post-mortem examination in such a case is illegal as well as being extremely dangerous for the person doing it. Only a veterinary inspector may cut into a vein in order to obtain a drop of blood for examination. Under a microscope the anthrax germs can be seen in the blood and from this a decision can be made as to whether anthrax is present or not.

Spores.

It will at once be realized why the law prevents the opening of a suspected anthrax carcase. The germs would escape from it in blood and other discharges and would be extremely difficult to remove from, or kill on, a contaminated floor because of the fact that they would rapidly form spores. If such spores get on to pasture it is impossible to remove them. At most the land can be limed and turned over but even then earthworms may bring living spores to the surface again. Such contaminated pasture may be dangerous to animals for years to come and cases of anthrax may occur on it from time to time. Anthrax carcases must either be burned or buried six feet deep with a layer of quicklime below and above the carcase.

Efficiency of Regulations.

It is very unusual for a serious outbreak of anthrax to occur in a herd of cattle, flock of sheep or in any other animals. Cases are found here and there at odd times. This is largely due to the efficiency of the regulations governing the control of the disease so that pasture or home-grown animal feeding stuffs rarely carry the germ. Many of the cases which do occur arise from the presence of anthrax spores in imported feeding stuffs such as cake. This is why sheep, although they are the most susceptible of our domesticated animals are more rarely affected than cattle; their diet is not augmented so often by the addition of imported foods.

In countries where the disease is very common vaccination against anthrax is practised with considerable success. In the British Isles however such a procedure is unnecessary and would not be justified economically. The cost of vaccination would be greater than the losses sustained from the occasional deaths from anthrax.

TUBERCULOSIS AND JOHNE'S DISEASE

The body, under certain circumstances, shows a distinct resistance to the progress of tuberculosis. In many animals the disease may be so slight as to be insignificant but the dairy cow shows a particular susceptibility. There are definite reasons for this. From the public health aspect the disease is extremely important and can be eradicated from herds with the aid of the tuberculin test. These and other matters connected with tuberculosis are described and discussed. Johne's Disease of cattle, a rather similar chronic condition, also receives attention.

(i)

Tuberculosis.

TUBERCULOSIS is undoubtedly the greatest scourge which is common to man and animals. In man, when it affects the lungs it is popularly known as consumption and many deaths occur from it annually, indeed the majority of people, particularly those living in cities, contract tuberculosis to some degree at some time or other but most of them overcome the condition without having been aware of its existence. Likewise in animals, particularly in dairy cows, tuberculosis infection is very common but again not all that have the infection show evidence of the disease. In the great majority of cases only some small remote part of the body is attacked and the disease may not progress any further.

Resistance.

Under certain circumstances the body shows a remarkable resistance to tuberculosis. In the early stages of the disease at least it could be arrested in most animals if they could be placed under sanatorium conditions with adequate rest, food and fresh air. However, recovery would be slow and since farm animals are kept for their usefulness such a procedure would not be economically sound.

Cause of Tuberculosis.

The cause of tuberculosis is a microbe called *Mycobacterium tuberculosis*. For many years research workers were baffled in their search for the cause of this condition since the germ could not be rendered visible under the microscope by the usual means. Eventually however, Robert Kock, a German scientist, succeeded where others had failed. Tuberculosis was established as being an infectious disease caused by bacteria; so that, unless a person or animal has been in contact with the infection, the disease cannot be contracted.

All domestic animals are susceptible to tuberculosis but it is essentially a disease of domestication and is practically unknown in wild animals. It occurs most frequently among those that are herded together and housed frequently; consequently it is most common among dairy cattle. In beef breeds it occurs less frequently since they live almost entirely out of doors and they are not in such close contact with each other. After dairy cows, pigs are the most frequently affected because of the close conditions under which they live. It is not uncommon in poultry and would probably occur much more frequently if these birds were permitted to live longer. Horses, dogs and cats are affected rarely and it is almost unknown in sheep since they are very rarely in contact with the infection.

Prevalence.

With respect to the prevalence of this disease in dairy cows, it may be pointed out that, apart from the methods of husbandry, there are other reasons why this should be so. Man takes from the cow all that she can be induced to give by way of milk and calves. She is bred and fed to produce maximum quantities of milk for some ten months of each year and normally she bears a calf annually. The result of this is that she is either "heavy in milk" or heavy with calf. The amount of milk which is produced is far in excess of that which would be required normally to rear a calf and cows are fed scientifically so that they get sufficient (and no more) to keep them in fair condition and to produce a certain quantity of milk. Dairy breeds do not get much opportunity to fortify themselves against disease and indeed the great majority of individual animals are constitutionally unable to utilize food to put on flesh to any extent. The bulk of it goes to making milk and even when they are dry they refuse to fatten.

It has been stated that the body can overcome tuberculosis in many cases, given a chance, but what chance has the dairy cow? It is not too much to suppose that, even slight tuberculous disease would be much less prevalent in these animals if they were managed differently. Advanced tuberculosis, although not so very common compared with the number of cows suffering from very mild disease, also occurs more frequently in these animals than in any other.

It must not be thought that the writer is advocating a complete reorganization of animal husbandry on the dairy farm. Cows are kept for profit and the way they are treated is dictated by force of economic circumstances subject of course to humanitarian considerations. The facts however are as stated.

Symptoms.

The germ of tuberculosis causes the same type of disease in all animals which it attacks. It can settle in almost any part of the body and different symptoms may appear according to the part of the body attacked. It can produce inflammation of the brain region (meningitis) with complete upset to the animal's sanity and normal movement; when it attacks the lungs chronic pneumonia is set up, while if the intestines are

affected diarrhoea and other bowel symptoms may appear. In general, if the disease is progressive, a slow-working chronic condition is set up and few if any symptoms may show until the malady is well advanced. Then general wasting of the body usually becomes apparent in combination with other symptoms.

The Activity of Germs.

When the organism settles in any part of the body and becomes active it commences to destroy the tissues with which it is in contact. These structures die and are converted into cheese-like material which in soft organs may be of fluid consistency at first. Thus, in the lungs the fluid may be expelled from the part by coughing, reach the windpipe and eventually be coughed up as sputum. In this way cavities may be formed in the lungs. This material which is coughed up will contain numbers of tuberculosis germs and, in this disease, where this happens it is called an "open" case. At other times, particularly when the malady is very chronic and slow working in nature, no infected material is passed out at all. Such is a "closed" case. The body reacts against the disease and an attempt is made by the body itself to restrict its advance. All round the tuberculous sore a tough, very resistant material, fibrous tissue, is produced, and the germ finds this extremely difficult to attack. Indeed the ravages of the condition may be completely stopped by this means, the affected part being walled off by fibrous tissue. Also the wall so formed can be reinforced by the formation of particles of calcium, stone-like material and if this calcification is complete the disease will have been very efficiently arrested. In order for such recovery to take place, to the extent of completely holding up the disease, an animal would have to be kept under optimum conditions as far as diet and other things are concerned and little could be demanded in the way of milk production and calf bearing.

Such cures from tuberculosis of the lungs occur frequently in humans if the disease is not too far advanced and if adequate treatment is given. In cows, however, it is doubtful whether complete arrest of the disease ever occurs once it has become active in these organs. A feature of the tuberculosis germ is that it rarely if ever dies off in the body once it has established itself. That its progress can be stopped we have seen. In some cases however where such has happened, if the individual is subjected to any great strain the disease may become active again. In dairy cows affected with tuberculosis that has been chronic and restricted in its effects, it sometimes happens that the act of calving will precipitate rapid progression of the disease, owing to the animal's lowered resistance at that time. An animal so affected will rapidly show severe symptoms and will probably die in a short time, if not slaughtered.

When the disease attacks parts of the body other than the lungs the effect is much the same as has been described; but the formation of cavities does not take place and, indeed, although attacking all parts of the body in the same way the resulting appearances of the parts attacked may be quite different. For instance, when the peritoneum is affected, there often arise raised pearl-like growths which may cluster together like bunches of grapes. The name "grape disease" has been applied to this. Again a tuberculous sore in the liver may have the appearance of a large abscess containing thick, cheese-like pus, gritty in consistency.

Most Common Form.

In cows, tuberculosis of the lungs is the most common form of the disease, once it becomes really active in the body, and as has been explained, recovery is rare. But apart from the presence of the germ in such a serious situation, very many animals have the infection in one or more of the tiny glands which are present in the body. There it may remain without progressing and such animals are quite healthy and show no signs whatsoever of the disease.

Public Health Aspect.

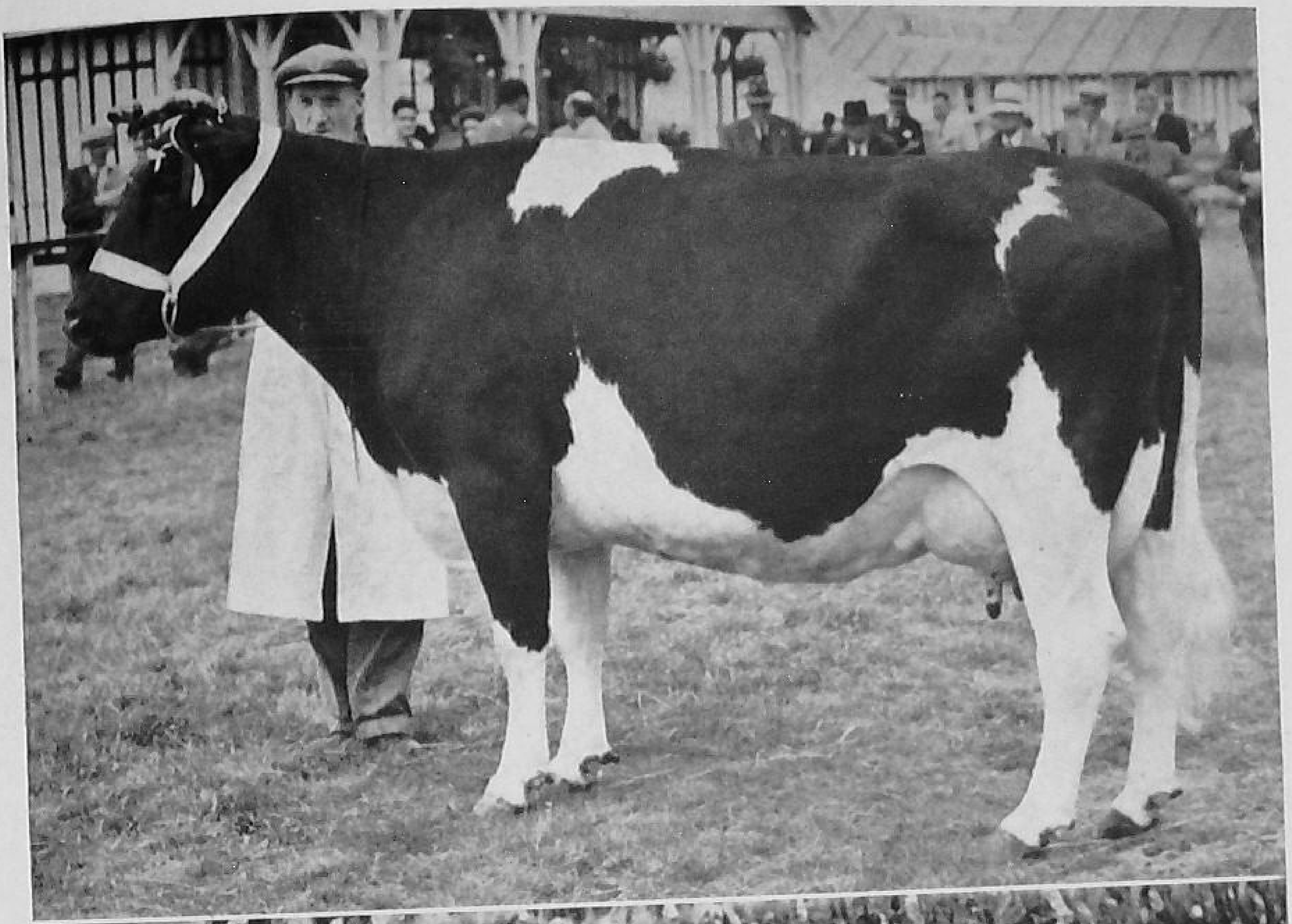
The public health aspect of tuberculosis is of great importance. There are three types of the the germ, the *human*, the *bovine* (which attacks animals) and the *avian* (which affects birds). Of the three, human beings are susceptible to the human and bovine forms. Children in particular may be affected with the latter type. In this respect milk containing the tuberculosis organism is dangerous, but for this to happen the cow's udder must be affected with the disease, and fortunately only a small proportion of infected animals suffer from disease of the udder. Nevertheless the number is sufficiently great to constitute a menace to public health. Cows with tuberculosis of the udder are subject to compulsory slaughter as are others which fall into certain categories of tuberculous disease.

Like many other infectious diseases tuberculosis spreads from animal to animal by passage of the germ. Probably the most common means in cattle is by sputum from lung tuberculosis. Likewise, if the intestine is affected, dung will convey the germ and so will any other infected body discharges.

As yet there is no known treatment by drugs which can be applied successfully to this disease in animals. However, when one considers the great advances which have been made in this method of treating disease it is not outside the bounds of possibility that one day some substance will be discovered which will be able to attack and overcome the microbe of tuberculosis in the body.

Tuberculin Test.

Tuberculosis is difficult to diagnose in its early



BRITISH BREEDS OF CATTLE

Above : BRITISH FRIESIAN

Below : HEREFORD

Farmer & Stockbreeder Photograph

BRITISH BREEDS OF CATTLE
Above : SHORTHORN BULL
Below : DAIRY SHORTHORN COW

Farmer & Stockbreeder Photographs

stages, particularly in large animals where the use of X-rays is not practicable. When the usual methods of examination for disease are relied upon, it is commonly well advanced before it is detectable and of course this means that other animals may have become infected in the meantime. Where any attempt made to eradicate or control tuberculosis by this kind of early diagnosis, the result would be absolute failure. The development of the tuberculin test however affords a means whereby all infected animals, even those with the slightest trace of tuberculous disease, can be determined. Thus it is possible to eradicate the disease from dairy herds. The tuberculin test has gradually undergone improvement until at the present time, although it may be troublesome to apply, it is very efficient.

Briefly, the test depends upon the fact that any animal, or human for that matter, that has the slightest trace of the disease in the body becomes sensitive to the toxin which is produced by the tuberculosis bacteria. The reaction is detectable and can be measured. For instance if a measured dose of the toxin is injected through the skin the result will be a rise in the animal's temperature above a certain point if it is infected with tuberculosis. This method of carrying out the test in cattle was used at one time and was called the subcutaneous test. Now however it has fallen into disuse. Again if a drop of the toxin be placed in the eye of an infected cow inflammation of that region with formation of a discharge will result. Still another method is to inject a small dose of the toxin into the thickness of the skin and in tuberculous animals a swelling will appear at that point. This is the intradermal test and is the only one which is now used officially in cattle in this country.

Tuberculin.

The tuberculosis toxin used for the purpose of the test is prepared in the laboratory. The germs of the disease are cultivated or grown in a fluid and the poison which they produce diffuses through that fluid. The germs themselves are then removed by filtering, leaving the fluid with the toxin in it. This product is then concentrated to a certain strength and the finished article is known as tuberculin and the test in which it is used is called the tuberculin test.

The full title of the test now used on cattle is the Double Intradermal Tuberculin Test; double, because two injections are given, intradermal because they are introduced into the thickness of the skin. The word means just that.

Injection.

To carry out the test a tiny dose of tuberculin is injected unto the thickness of the skin of the neck, its thickness having been measured prior to this. Seventy-two hours after this the skin thickness at the site of the injection is measured again and the final result of the test is known.

By means of the measurements taken the extent of the skin swelling which has resulted from the injection can be determined exactly. Swelling beyond a certain limit constitutes a positive reaction and the particular animal is infected with tuberculosis to some extent at least.

Avian Infection.

On occasion cattle become temporarily infected with the avian or bird type of the tuberculosis microbe. This fact is of no importance whatsoever from the point of view of the infection producing actual disease and animals temporarily infected in this way are looked upon as being quite sound. Unfortunately however such a state of affairs complicates the modern tuberculin test in that animals so infected will show a positive result to the test. To overcome this difficulty all cattle, where avian infection exists or is known to have existed in a herd, are tested with tuberculin made from the avian type of the germ. This is done at the same time as the other test and a comparison of the two results is made. Where the swelling resulting from the injection of avian tuberculin is sufficiently greater than that occurring after the injection of the bovine tuberculin then the animal has an avian infection and it passes the test.

Criticism.

There has been much criticism of the tuberculin test as applied to cattle. The fact remains however that very many herds have been cleared of the disease by its repeated application and the removal of all infected animals. It is not claimed that it is one hundred per cent efficient. Doubtful reactions arise quite frequently and instances are not unknown where an animal fails the test in one instance only to pass a subsequent test applied some two months later. This does not occur frequently but it can and does happen. The question however is whether it is better to use a tuberculin which detects practically all infected animals but which, at the same time, may condemn an odd one which has not the disease, or, a tuberculin which never gives a reaction in a non-infected beast but will allow some to pass which are infected. Bearing in mind the seriousness of the condition from a national point of view and the fact that the test is being used primarily to eliminate the disease from dairy herds, the reader is left to judge for himself. Perhaps, in time, a tuberculin will be found which has none of the drawbacks of that in present day use.

(ii)

Johne's Disease.

In cattle and sheep a disease is to be found which has certain similarities with tuberculosis. It is called Johne's Disease. Once animals become visibly affected they rarely, if ever, recover

and it is a chronic slow-working condition. Its cause is a germ, *Mycobacterium johnei*, which is a close relation to that which causes tuberculosis. Again, like tuberculosis, if the vitality of the animal is lowered, such as by the act of calving or by any other disease, Johne's Disease may pursue a much more rapid course.

Infection of sheep with this condition is not common but it occurs frequently in cattle, particularly in some parts of the country. Channel Island breeds of dairy cows seem to be particularly susceptible or it may be that the disease has existed in such herds since the time of their formation and it has never been eradicated. Whatever the reason, in the writer's experience Johne's Disease occurs frequently in the Jersey and Guernsey breeds. However, any breed of cattle can contract the condition and it can cause serious annual losses where infection is extensive. The bacterium causing Johne's Disease always attacks the wall of the intestine or bowel, particularly near its terminal part, that is the rectum and the few feet of bowel which connect with it. It never travels far from this situation. The affected bowel becomes thickened, inflamed and reddened in patches and its lining is raised in numerous corrugations.

Symptoms.

The symptoms are mainly wasting of the body and diarrhoea, constant or intermittent and frothy in nature. The wasting or emaciation may progress slowly and the animal may last for a considerable time. Some improvement may become apparent on occasion. However, sooner or later the disease seems to become more active, and the infected animal becomes weaker and weaker, the diarrhoea more profuse, and eventually the animal dies if it is not slaughtered.

Diagnosis.

The diagnosis of Johne's Disease is not an easy matter. All animals with diarrhoea are not necessarily affected with this condition and in the early stages it is impossible to detect. A feature of the malady is the very long period which may elapse between the first contraction of infection and the time when symptoms become evident; or, in other words, the incubation period is protracted. There is considerable evidence to show that only the young are susceptible to infection and that most diseased animals contract it as calves. The organism lies dormant, perhaps for years, and symptoms of the disease do not appear until later in life. It is almost unknown for cattle to show signs of Johne's Disease under the age of eighteen months. The limit of the period of susceptibility is, however, not known.

Johnin Test.

A test similar to the tuberculin test has been developed for the detection of Johne's Disease but it is notorious for its unreliability and is not to be recommended for using in an attempt to free a herd from the disease. It is known as the johnin test and is occasionally used in odd cases where diagnosis is particularly difficult but in many cases it is not very helpful. Examination of samples of dung under the microscope will sometimes show the germ to be present and in such cases there is no doubt about the presence of the disease. Frequently however the examination of dung from infected animals will not reveal the microbe, so that this method of diagnosis is by no means conclusive unless it is definitely positive.

There is no known method of treatment which has the least effect on the course of Johne's Disease.

What We Know of the Disease.

To attempt to control the condition one must consider what we know of the disease. Firstly the dung of all animals in which the disease is active will contain numbers of the germ. This will contaminate pasture, cowsheds and any natural accumulations of water which may be present where cows are. Again, there is the point that only the young seem to be susceptible to infection. Control measures depend on getting rid of all infected animals immediately the disease reveals itself with reasonable certainty and preventing the access of calves to possible infection. This latter is not easily accomplished, particularly when we consider that cows' teats may be contaminated with infected dung and suckling calves may thus contract infection soon after they are born. Again it is a common practice to allow young stock to follow the cows in the grazing routine and of course under these circumstances they are liable to pick up the infection. It must be remembered also that the boots of workers may carry dung into the calf houses and so introduce the infection.

Calves.

In general, calves should be reared quite separate from the adult stock and all precautions should be taken against introducing the disease among them. At grass they should be kept away from pasture which has been contaminated at all recently and due consideration should be given to the possibility of calves being infected while suckling. It is essential that the calf should get the first milk or colostrum of its mother and this must be given by bucket feeding or the calf allowed to suckle for a day or two. In the latter case the calf should be allowed access to the cow only at certain times and her udder should be specially cleansed and disinfected on each occasion. Where bucket feeding is practised from birth the danger is not eliminated. Dung from a dirty udder may get into the bucket, therefore the same precautions should be observed. On all occasions buckets should be scrupulously clean.

It is realized how extremely difficult it is on the ordinary dairy farm to carry out these advocated measures effectively, but it is only when they are conscientiously and scrupulously applied that any improvement can be expected.

Vaccination on Trial.

At the time of writing a method of vaccination of calves against Johne's Disease is on trial in this country and preliminary reports are encouraging. There is some reason to hope that it will be largely successful in preventing the disease. However, so many measures of treatment and prevention of disease have fallen far short of what was originally claimed for them, that it is always best to be prepared for failure until their value has been proved beyond doubt by a verdict resulting from unrestricted use.

DISEASES CAUSED BY ANAEROBES

Some Important Sheep Diseases

A very important group of diseases is dealt with here. Blackquarter of young cattle causes severe losses in some areas and Tetanus, although not so common, is frequently a killing disease; its effect on horses is described in some detail. Here also are described some of the most prevalent diseases of sheep, namely, Braxy, Lamb Dysentery, Pulpy Kidney Disease and Struck. Methods of prevention are available for all but in most cases cure is impossible.

(i)

Anaerobes.

The reader will remember that, in the section where bacteria and their effects on the body were described, certain organisms were called anaerobes. These are germs which refuse to grow or multiply in the presence of free oxygen. This means of course that they cannot be cultivated in the laboratory unless air is excluded from the medium in which the attempt is being made. However, in the body many can find situations that are very suitable for their development and the diseases caused by such bacteria are extremely important, particularly those that affect sheep.

Spores.

Also, many of the disease-producing anaerobes have the faculty of being able to form spores and therefore they are extremely resistant to adverse conditions. Most of these sporulating anaerobes, as they are called, exist in soil in the spore form and can remain alive for many years. This applies particularly to soil and pasture which has been contaminated with dung from animals. The reason is that many of these organisms *normally* inhabit the intestines of man and animals and do no harm. From this situation they are passed on to soil and pasture.

Toxins.

A further feature of the sporulating anaerobes is their ability to produce toxins, some of which are extremely potent in character. In certain diseases produced by such bacteria it is the toxin that is all-important and it frequently kills the individual which is attacked. An example of the devastating effect of one of such toxins is that produced by the anaerobes which cause Tetanus or Lockjaw. A dose of one thousandth part of a cubic centimetre injected into a mouse will kill it. This amounts to about a sixtieth part of a drop.

(ii)

Lockjaw.

Tetanus or Lockjaw affects, principally, man and horses, but lambs are attacked quite frequently. In almost all cases the germ, *Clostridium tetani*, enters the body through a visible wound such as the injury to the foot of a horse that has trodden on a nail. Infection of wounds is most likely to occur when they are deep and narrow in character, that is, punctured wounds. The origin of the infection is contamination with dirt on the particular object that caused the wound, Tetanus spores being present in the dirt. Punctured wounds are particularly susceptible to development of this germ because of the fact that they tend to close quickly at the surface enclosing the bacteria deep in the wound and cutting off access of air. This creates the oxygen-free conditions which are necessary for the development of an anaerobe such as the Tetanus germ. In horses this is the usual method by which they contract the disease, that is, through a punctured or deep-seated wound.

Lambs.

In lambs however Tetanus may arise without such a wound. It is most common after docking or cutting of the tail and can develop after castration. In the latter case it is quite conceivable that the germ can be enclosed in a contaminated wound which has healed over too quickly. After docking however this possibility does not seem to arise, the wound always being superficial and never penetrating. In such cases however the development of a scab probably eliminates air from the raw surface of the wound.

Potent Toxin.

As has been stated the Tetanus organism produces an extremely potent toxin and it is this which causes the disease and is responsible for its symptoms. The germ itself remains in the wound, multiplies there and never shows any tendency to invade neighbouring parts of the body. The toxin however is absorbed from the affected parts and always attacks nerves, at length reaching the brain. Here those parts of the brain which control the actions of muscles become involved resulting in the well-known symptoms of the disease. Muscles become rigidly contracted and movement of various parts of the body is thus prevented. The limbs may be incapable of being bent, the tail may be rigidly stretched out and the mouth cannot be opened. This last results from the fact that the muscles which cause closure of the jaws are constantly in action and cannot be relaxed, hence the name "Lockjaw."

In the Horse.

In the horse the symptoms commence with stiffness which may occur almost anywhere in the body, but before long the legs are obviously affected. As the disease progresses the forelegs become stiffly straddled and the hind legs either in a similar position or drawn forward under the

body. The animal sweats, breathes fast and is very excitable; the lips may be drawn back showing the teeth. The jaw muscles are almost always involved and feeding may become impossible. Different postures and symptoms may appear according to the muscles affected. An almost constant symptom in the horse is protrusion of the membrane or " haw " situated at the inner corner of each eye.

Treatment.

With respect to treatment, the first necessity is to remove as far as possible the source of the trouble. Therefore, it is essential that the wound should be attended to properly in the way of cleansing, disinfection and perhaps cauterization. In some cases the veterinary surgeon may cut out entirely the contaminated wound in order to create one which is clean and not infected. Large doses of antitoxic serum are injected to counteract the action of the toxin. Apart from these, the essential part of treatment is to keep the excitable animal in absolute quiet and to exclude light; it is best to keep the horse in a box. As long as feeding is possible food should be soft and highly nourishing. With adequate treatment and nursing quite a few affected horses will recover.

In lambs, an affected animal usually lies flat on its side with all four legs stretched out stiffly and the head drawn back. These animals, once affected invariably die and it is best to put them out of their misery.

Tetanus can be prevented by the inoculation of serum which will neutralize the toxin; in other words, it contains anti-toxic antibodies. As with all sera, the protection thus afforded is temporary in nature, and so it is used at times when animals are likely to develop the disease, as when a wound has been received. In districts where Tetanus is common this is a wise procedure. It is questionable if such a measure is economically sound, however, to prevent losses in lambs, which may be few in number. However, where a considerable number of deaths are expected to occur from this disease, they can be prevented.

The serum, given in large doses, is also most valuable in the treatment of the condition.

Cattle, pigs and dogs may also be affected with Tetanus but this does not occur often. In these animals the symptoms are similar to those described and treatment is identical.

(iii)

Gangrene.

There is a group of the sporulating anaerobes which can cause gangrene in man and animals. Gangrene is death of the part affected followed by putrefaction, consequently there is a putrid smell from such affections. A peculiarity of these organisms is that they produce gas and in parts of the body which are attacked numerous little bubbles of gas are to be found. Hence the term " gas gangrene " which is often applied.

Blackleg.

In cattle the common form of gas gangrene which is found is known as Blackquarter or Blackleg. Other names such as " Quarter Ill " or " Quarter Evil " have been applied to it. Calves and young animals up to about two years of age are susceptible and very often it is not known how the organism gained entry to the body because no wound is visible. The common cause is a sporulating anaerobe called *Clostridium chauvoei*. It affects muscle mainly, a hot painful swelling resulting which crackles slightly when it is pressed or stroked. This is due to the presence of gas bubbles in the muscle. The condition spreads quite rapidly and as well as the immediate effects of the invading organisms there is a general illness caused by absorption of toxin from the part. Some hours afterwards, the original swelling becomes cold and painless due to the part having died; but round this, where the disease is extending, heat and pain may be found. Death usually takes place within forty-eight hours particularly in young animals.

Usually it is the upper part of one hind leg which is affected in cattle and consequently slight lameness may be the first symptom noticed. The animal refuses to feed, breathes quickly and runs a high temperature. Examination will often reveal the swelling.

Sheep.

In sheep the disease is generally associated with a wound or injury, the organism having gained entry by this means. The resulting disease is identical with that just described. It may follow injury during lambing, shearing, docking or castration and particular pastures are known to be dangerous from the point of view of their being contaminated with the germ.

Once this disease has attacked an animal there is no treatment available at the moment which has any effect. Prevention by inoculation of serum is practised where the disease is prevalent, the serum neutralizing the toxin produced by the bacteria.

(iv)

Entro-Toxaemia.

It is certain that of the diseases which affect sheep those which are caused by sporulating anaerobes are the most prevalent and the most serious. There is no area in the country where such conditions are unknown among sheep, although certain of them are restricted to certain localities. Sheep are particularly susceptible to the effects of a number of these bacteria and their toxins. Apart from the Gas Gangrene type of disease the source of these infections is some part of the digestive system, where, it will be remembered, these organisms live normally. Under certain circumstances they commence to

multiply in very great numbers and toxin is produced. It is this toxin that is the major killing agent since it gets into the system by being absorbed from the intestine. In certain cases, the bacteria themselves invade the wall of the stomach or bowel but the very rapid death which takes place is due to the poisonous effects of the toxin. The term *Entro-toxaemia* has been applied to these conditions, which means simply that a toxin is present in the blood which has been absorbed from the intestine where, of course, it has been produced by the bacteria.

Braxy.

Such a disease is Braxy. It occurs among hill sheep in Great Britain and Ireland and is most common in western districts. Losses occur any time from late autumn to early spring. Death is very rapid and it is rare to find an affected animal alive. The condition is most prevalent in animals which are thriving well and it is usually the best in the flock that suffer. Also it is confined almost wholly to yearling sheep, although in districts where the disease is particularly prevalent two-year-old animals may be affected. The death rate from this condition varies from year to year but a ten per cent loss is common and may be much higher.

Braxy commences with invasion of the wall of the fourth stomach or abomasum by the bacterium which causes the disease, *Clostridium septique*. It causes severe inflammation of the affected part and may progress further and attack the liver or other organs. In some cases it may even be found in the blood stream. The animal usually dies within a few hours, death having been due to the action of the toxin produced by the bacteria. Carcases dead from Braxy usually putrify very quickly and rapidly become swollen with gas.

Frosted Pasture.

It had long been suspected that the occurrence of hoar frost had something to do with the development of Braxy since cases were common when hoar frost occurred. This has never been actually proved but it is probably correct. The theory is that frosted pasture, when consumed, has a chilling effect on the stomach wall. The inflamed part of the abomasum is commonly found in that part of the wall which lies against the rumen or paunch which has contained the grass. This chilling presumably lowers the resistance of the part to the action of the bacteria and so the disease develops. From this the practice has arisen of folding sheep during the night and giving them a feed of hay before releasing them to the pasture in the morning. Cases occur and die most commonly during the night, the suggested reason for this being that the chilling of the stomach occurs in the morning, the disease gradually develops during the day and becomes acute the following night, when the animals dies. There must be other reasons than this, however, which determine susceptibility, since the foregoing cannot explain why the best sheep usually succumb, while others in not such good condition escape.

Braxy can be largely prevented by inoculation of vaccine. The vaccine contains killed Braxy germs together with modified toxin. The result is the development of an immunity directed against the bacteria and the toxin which they produce. Vaccination is carried out early in September so that an effective immunity may be produced before the Braxy season commences; it is confined to the young susceptible animals.

Lamb Dysentery.

An enterotoxaemic disease of young lambs is Lamb Dysentery which most commonly affects these animals in the first week of life although, on occasion, cases may occur rather later. It is common in well-defined Lamb Dysentery areas such being in North Wales, West Scotland, the border counties between England and Scotland and elsewhere. Again, the cause is a sporulating anaerobe, *Clostridium welchii*, and losses vary from year to year; but in bad seasons half the lamb flock may be lost.

Affected lambs, to begin with, lag behind the ewe and then become prostrate. Diarrhoea is usually evident and the hind quarters are coated and stained with it. When the lamb is no longer able to move a pool of excreta may be found behind it. The colour of this discharge varies from yellow to dark brown and it often is streaked or mixed with blood. Once symptoms develop the affected lamb always dies within a few days.

The bacteria responsible for the disease multiply very rapidly in the bowel and produce toxin. The wall of the bowel becomes acutely inflamed and numerous ulcers may develop in its lining. The inflammation sometimes extends through the intestinal wall and sets up peritonitis, in which cases loops of intestine are found adhering to each other. The animal dies from the effect of the toxin which is absorbed into the system.

Virulence Enhanced.

A peculiarity of Lamb Dysentery is that the severity of the condition increases as an outbreak progresses; a greater proportion of new born lambs is attacked and they die more quickly. The organism is at first taken in by the mouth, probably from contamination of the ewe's teats. Once having caused the disease, its ability to do so is increased, that is, its virulence is enhanced. Affected lambs are constantly contaminating the pasture with such dangerous germs which, when they get into the intestine of a further lamb, soon after, will get to work more quickly and more severely; and so it goes on.

Losses Prevented.

Losses from Lamb Dysentery can be prevented

to a great degree by either of two methods. One is to have the ewes vaccinated against the disease, the vaccine again containing killed germs and modified toxin. When being vaccinated for the first time ewes are usually given two doses of vaccine, one in the autumn and the other about fourteen days before lambing. The resulting immunity in the ewe is conveyed to lambs in the first milk or colostrum, antibodies being contained therein. The second method is to inject serum into lambs within the first twenty-four hours after birth, the serum containing ready made antibodies. Both methods give the lamb a temporary protection but one which is, nevertheless, able to carry it through the susceptible period, that is the first ten days or so of its life. Vaccination of ewes, although not quite so efficient as the use of serum in the lamb itself, is the method of choice in hill and inaccessible areas where it is practically impossible to inject serum into all lambs in their first day of life.

Pulpy Kidney Disease.

Another disease, mainly of lambs with which shepherds are becoming increasingly familiar is Pulpy Kidney Disease. It is a fatal disease which affects animals most commonly between six and sixteen weeks of age but it can occur at almost any age. Of the anaerobic diseases of sheep this one is the most common and it occurs, to some extent at least, wherever sheep are kept. However it is more prevalent in some areas than in others and like other diseases of this nature the number of lambs affected varies greatly from year to year. In a bad year the death rate can be as high as ten per cent in certain flocks. The best lambs in a flock die of the condition more readily than those which are not thriving so well. It is particularly prevalent in seasons when there has been a mild, open spring and a good growth of grass and when the ewes have wintered well. Under such circumstances ewes have plenty of milk and the lambs make headway quickly These are the circumstances under which Pulpy Kidney Disease is most liable to occur.

Clostridium Welchii.

Like Lamb Dysentery the cause is *Clostridium welchii* and the disease is perhaps the most typical of those which can be classified as enterotoxaemias. Again the organism is frequently present in the intestine of normal animals and commences to multiply in enormous numbers and to produce toxin. When large numbers of these bacteria are fed to lambs in an attempt to reproduce the disease it has been found that there is no result unless abnormal amounts of milk are given to the lambs as well. Only under these circumstances can the disease be caused experimentally. Just what the necessary conditions in the intestine are to enable the germ to multiply so prolifically is not known, but it would seem that overfeeding with milk must create circumstances in the bowel which permit this. It may be mild indigestion. To some extent this explains why it is usually the most advanced lambs that are affected. Death of course is caused by absorption of the toxin from the bowel into the system.

Misleading Name.

Pulpy Kidney Disease is a misleading name since it describes the mushy condition of the kidneys that is found some hours after death in animals that have died from the condition. Carcases opened immediately after death may have kidneys which are practically normal in appearance. The cause of death is often thought to be " wool ball " by shepherds who find lambs dead. Wool can be found in the stomachs of most lambs and death from this can result, but only where the exit from the stomach is obstructed by a matted mass of wool. Many cases of supposed wool ball in lambs are really Pulpy Kidney Disease.

It is impossible to predict when this disease will make its appearance among lambs since it varies so much from year to year.

All Lambs Die Quickly.

As far as is known all lambs affected with Pulpy Kidney Disease die, and die quickly. It is unusual for symptoms to be noticed some hours before death, but this occasionally happens. Affected lambs are dull and unable to rise. In a short time they lie on their sides unconscious, often with the head drawn back and the limbs stretched out stiffly and showing jerky movements. It is possible at this stage to mistake the disease for Tetanus. However, in Tetanus death is much slower than from Pulpy Kidney Disease, in which the comatose animals will be dead within a short time. However, by far the greater proportion of lambs which die from this condition are found dead without previous symptoms having been noticed.

Findings in the Carcase.

There is one body change which is almost always found in lambs which die of Pulpy Kidney Disease. The sac which surrounds the heart, the pericardium, almost always contains a considerable quantity of fluid which may be of a clear straw colour or blood tinged. In the heart itself, either on the external or internal surface, or both, there are to be found small haemorrhages or bleedings. These findings in the carcase of a lamb which has died suddenly and is of the susceptible age make it practically certain that it died of Pulpy Kidney Disease. As has been said one or both kidneys may become " pulpy " some hours after death. If the capsule is stripped from these organs and if they are squeezed within the closed fist they will commonly be pressed out between the fingers, if pulpy. Immediately after death little or no change may be observed in the kidneys.

Prevention by Injection.

Pulpy Kidney Disease can be largely prevented by injection of serum into lambs. The procedure of inoculating all lambs against the disease every year is never carried out, since regular annual losses are not experienced. However, once the condition has commenced in a flock deaths can very often be stopped immediately by injecting all lambs with serum. The serum gives an immediate protection against the toxin of the Pulpy Kidney bacteria which seems to last sufficiently long to carry the lambs through the susceptible period.

It has been found also that removal of ewes and lambs to a less rich pasture may have a beneficial effect.

In Older Animals.

An identical disease occurs quite commonly in adult sheep and weaned lambs but most frequently in those under two years of age. Again *Clostridium welchii* is involved but the pulpy condition of the kidney is rarely evident in older animals and the term Pulpy Kidney Disease is therefore restricted to the disease in suckling lambs. In older animals it is called simply Enterotoxaemia. Examination after death often reveals little in the carcase which will aid a diagnosis and other methods have to be adopted which will be explained later. On occasion there is some fluid in the pericardium or haemorrhages in the heart but by no means always.

Fatalities and Rich Pasture.

Animals feeding on rich pasture are subject to Enterotoxaemia particularly when they have been recently introduced there from poorer keep. Similarly those being folded on a nutritious crop may show some fataílites from the condition to begin with. It is rare that losses are many; usually only one or two succumb, although the writer has seen half a dozen yearling sheep lying dead one morning, they having been first folded on the previous day. Usually, but not always sheep dying of Enterotoxaemia are in very good condition. One form of remedy is obvious. Remove the animals to poorer pasture or from the fold. Like Pulpy Kidney Disease deaths from Enterotoxaemia can be stopped by the use of serum but one has always to consider the number of animals involved, the likelihood of further deaths and the cost of inoculation. Also, there is available a vaccine which like the one used to prevent Braxy, contains killed bacteria and modified toxin so that an immunity against the bacteria and the toxin results.

"Struck."

One other form of Enterotoxaemia in sheep has still to be mentioned which is again caused by *Clostridium welchii.* It has been found so far only in two areas, The Romney Marsh district of Kent and in North Wales. It has been given the name "Struck," a term which is applied locally by shepherds in Romney Marsh because of the sudden death occurring in affected sheep. This term may be used in other areas to describe conditions which have no relationship with the "Struck" of Romney Marsh.

Up to ten per cent of sheep on a particular pasture may be lost in one year and certain pastures are noted as carriers of the condition. The disease is most common in late winter and spring and attacks sheep of more than a year old. Animals die suddenly and symptoms are rarely noticed before death. There is often an accumulation of fluid in the abdominal cavity but other changes in the body are often conspicuous by their absence, if the carcase is examined immediately after death. Again, the cause is absorption of toxin produced in the bowel by the multiplication of large numbers of bacteria.

Struck can be prevented by vaccination, the vaccine being of similar composition to that used for ewes to prevent Lamb Dysentery.

The Same Bacterium.

The reader will have realized that here are three diseases of sheep, each different in some way, be it in the affects of the disease or in the different ages of the animals attacked, yet all are caused by the same bacterium, *Clostridium welchii.* Apart from the fact that all are due to absorption of toxin from the intestine produced by the same germ in each case, there are few other similarities. It seems rather unusual that in these cases the one organism and its toxin attacking the same species of animal should have such different effects.

Types A, B, C and D.

Of course there is a reason. There are four types of *Clostridium welchii* known as type A, B, C and D. They are identical in every respect except that each type produces a different combination of toxins. It is interesting to note that type B produces toxins which are a combination of those formed by types A, C and D so that a serum prepared and having antibodies which will neutralize all the toxins of type B will also give some protection against the effects of the other three types. This fact has a practical bearing as will be seen later.

Clostridium welchii type A is primarily responsible for gas gangrene in man and is not known to affect sheep. Type B causes lamb dysentery, type C produces struck and type D brings about pulpy kidney disease of lambs and enterotoxaemia of older sheep, really the same disease. It has been noticed that lambs which have been inoculated against lamb dysentery early in life exhibit some resistance to the development of pulpy kidney disease later. Remembering that lamb dysentery is caused by type B, reference to the last paragraph will explain the reason for this.

Laboratory Diagnosis.

There is one other point which might trouble the enquiring mind. It has been stated that in some cases of these enterotoxaemic diseases of sheep few if any changes typical of the condition occur in the body. This being so, how are such cases diagnosed? It is true that one may suspect strongly what the condition is by reference to the age of the animal and the circumstances surrounding its death. However it is essential in some cases that one should be absolutely certain of the diagnosis and often this can be done only in a laboratory. The reader may find it of interest to learn something of the methods employed.

Tested in Mice.

In diagnosing these diseases of sheep in the laboratory the first step is to establish that toxin is present in the intestine, because, if it is there, it must have been produced by bacteria. To do this the contents of a portion of the intestine of a carcase are taken and passed through an extremely fine filter which will hold back all bacteria but will allow toxin to pass through. The fluid which results is then tested in mice for the presence of toxin. A small quantity is injected into a vein of a mouse and if this animal dies within a sufficiently short time, twenty-four hours or less, then toxin is presumably present.

Which Type of Toxin

The next thing is to determine which type of toxin or toxins has killed the mouse. For this purpose the laboratory has serum which will neutralize the toxin of *Clostridium welchii* type A, and separate similar sera for types C and D. A series of mice receive further injections of the toxic fluid but each mouse receives a dose of one serum as well as the toxin, so that one mouse will get toxin plus type A serum, another toxin plus type C serum and a third type D serum plus toxin. Whichever serum will save the life of a mouse will determine which toxin is present in the fluid and confirm the diagnosis of the particular disease. Thus if the mouse which received toxic fluid plus type D serum survives and the others die then *Clostridium welchii* type D has caused the disease; that is pulpy kidney disease of lambs was present or enterotoxaemia if an older sheep was involved.

It will have been noticed that type B serum was not used in these tests. As has been said, this will protect against all types of toxin therefore it is of no value for these purposes except where the disease has been caused by the type B organism, that is lamb dysentery. In such a case, were the test used, types A, C and D sera, used individually, would all fail to save the mice. A mixture of C and D sera however would do so and the organism would be identified as type B.

Such tests are not necessary in all cases of the foregoing disease of sheep. They are used occasionally, however, in the identification of pulpy kidney disease and frequently to diagnose the similar condition which affects older sheep, that is, enterotoxaemia. It is sometimes necessary to apply them also to be certain of the presence of struck.

MORE SHEEP DISEASES

The author deals with a miscellaneous selection of sheep diseases. They are not related in any way, one being caused by bacteria, two by filtrable viruses and in the others neither infective agent is the cause. The diseases dealt with are Foot Rot, Louping Ill (Trembling), Scrapie, Pine, Swayback and Pregnancy Toxaemia (Twin Lamb Disease).

(i)

Foot Rot.

Foot Rot can be a particularly troublesome disease in sheep and is the cause of severe lameness which results in difficulty in grazing and consequently in loss of condition. It seems almost certain that it is caused by a bacterial infection beneath the horn of the hoof and the organism which has been primarily incriminated is called *Fusiformis nodosus*. The condition is contagious and although it does not spread directly from animal to animal, contaminated pasture often results in serious outbreaks. Once the condition has started large numbers of other bacteria invade the sore which results and these play their part in the progression of the disease.

When the foot is affected at first there is a mild inflammation in the space between the toes. Later separation of the horn from the hoof begins, usually where the skin of the leg joins the horn, at the back of the leg. The horn gradually becomes separated to a greater and greater degree and may peel off completely from the under surface of the affected hoof. When this happens and where the horn becomes separated, a raw red sensitive surface is exposed. There is usually an evil-smelling discharge from the part. Usually both toes on more than one foot are involved and affected animals may commonly be seen grazing on their knees because of the pain caused by standing and moving about. Animals of all ages are affected and this helps to differentiate the condition from abscess of the foot which is most prevalent in adult animals. Moreover, in the latter disease usually only one foot is affected and there is evident suppuration with formation of pus.

Prevention of Foot Rot.

Prevention of foot rot is largely a matter of keeping animals off infected pasture and the quick removal from the flock of affected sheep once the disease is noticed. It has been shown that a pasture so contaminated does not remain dangerous for more than fourteen days provided that no sheep have been kept on the pasture during this period. Such of course would keep the disease going. Where the disease has broken out and before non-infected animals are placed on clean pasture they should all be passed through a foot-bath containing water with five per cent copper sulphate or bluestone dissolved in it. After this they should be examined frequently for the presence of footrot and passed through the bath again at weekly intervals until it is certain that no further cases of the disease are going to appear.

Animals which are affected should be treated individually. All horn which is at all separated from the parts underneath should be cut away and the best and quickest remedy is to place the affected feet in a pot containing a thirty per cent solution of copper sulphate for at least ten seconds. This should be repeated every few days.

It is certain that wet and muddy pastures are most liable to carry foot rot but at the same time if the germ is not present in such situations no foot rot will result. Again, if the horn of the feet is free from cracks it is unlikely that foot rot will develop since the organism must have some point of entry to the tissue under the horn. In this respect regular attention to the feet of all sheep is essential and all excess horn should be pared down. Overgrown feet always develop cracks. Another point is that animals which carry the infection can exist without showing evidence of lameness. These can be detected usually by careful examination and thorough paring of the feet which are often misshapen. Treatment should then be applied to them.

The best way to prevent foot rot is to have a careful shepherd who keeps the feet of his animals in good condition, attends promptly to any outbreak and who prevents introduction of the disease to a clean flock and pasture by making certain that such disease does not exist in the feet of any incoming animals.

(ii)

Louping Ill.

Louping Ill or Trembling is a virus disease of sheep found in the hill districts of Scotland and in Northern England. It is not transmitted directly from animal to animal but is carried by a sheep tick, a blood-sucker. If a tick first bites an infected animal and then, at a later stage of its life, bites another and healthy sheep it will transmit the virus to it, the virus having persisted in the tick. Thus the disease is most prevalent during the parts of the year when ticks are most active, that is, from March until June and then again in September.

Ticks.

Ticks are little insect-like creatures that feed on the blood of sheep and other species of animals. They are not true insects of course; they have not the correct number of legs to be classified as insects and there are great differences in their bodies as well. For their continued existence they prefer land in which there is a heavy tangled undergrowth which will preserve moisture and not dry out in summer. Consequently ticks are most common in heather covered hills and rough scrub pastures. The species of tick which

carries louping ill, *Ixodes ricinus*, is found solely in such places.

The female tick lays its eggs in crevices in the ground at the roots of the vegetation, in spring or in autumn, the season depending upon the time at which the female tick has reached maturity. If it is spring, the eggs develop quickly and hatch out the following summer whereas eggs laid in autumn develop slowly all winter and hatch in the spring. From the egg comes a stage which cannot develop further until it has attached itself to a sheep or other suitable animal in order to obtain food by sucking blood. This blood-sucking continues for three to five days then the young ticks drop to the ground again and moult. The moulting means that they lie dormant for a time, then cast their skins and emerge as the next stage in the development of a tick, known as a nymph. Nymphs again must attach themselves to a suitable animal known as a " host " and the host, from the nymphs' point of view, is preferably a sheep. Nymphs feed by sucking blood for four to seven days; then they in turn drop off and moult to emerge as adult male or female ticks which again gain access to a host, the female feeding for from four to eleven days. The male does not suck blood to any extent and his only mission seems to be to fertilize the female which, when it has fed to repletion, drops to the ground and lays eggs; so the whole cycle starts again.

Life Cycle.

Each tick then, in the course of its development from the egg has fed on three different animals and on no more. Once the female tick attaches herself to a host she bores her mouth parts through the skin and commences to suck blood. This applies also to larvae and nymphs. They do not move about on the animal but remain attached to the one spot until the meal is finished when they drop off. Such a means of development, divided into different stages, is called a life cycle. The minimum time taken by the complete life cycle of the tick is eighteen months and the maximum about four years. It can be slowed up to this extent by climate and the scarcity of hosts.

There is no evidence that the virus of Louping Ill is carried through the egg to the next generation of ticks, nor therefore that the blood-sucking larvae are carriers before they have fed on an infected sheep. They will not attach themselves to another sheep until they reach the nymph stage, therefore nymphs and adult females alone carry the disease. An infected nymph will develop into an infected adult.

Visible Symptoms.

When a susceptible sheep or lamb is bitten by an infected tick the virus first multiplies in the blood and the only symptoms are a rise of temperature and possibly dullness and loss of appetite. Many sheep recover from this stage of the disease without its having progressed farther and without symptoms having been noticed. In others however the disease progresses and attacks the nerves and brain. Visible symptoms then develop; these are excitability, trembling, particularly about the head region, and difficulty in walking. Some may be unable to stand. Death may result, while those animals which recover may be left with a partial paralysis of the hind quarters.

Natural Resistance.

Recovered animals acquire a strong and lasting immunity against future attacks. It is interesting to note that sheep born and reared on tick-infested Louping Ill pastures show a natural resistance to the disease which others do not. Under such circumstances the death rate rarely exceeds five per cent but if new sheep stock is introduced sixty per cent may die of Louping Ill. It is possible that lambs acquire some resistance from their mothers by means of the presence of antibodies in the first milk. This acquired immunity in the lambs is probably strengthened by bites from infected ticks, the virus so introduced acting as would a vaccine, without causing the disease.

This acclimatization of sheep stocks to certain pastures from the point of view of disease resistance is a well recognized fact among hill sheep farmers and adds considerably to the value of the animals. Land rarely changes hands without the sheep going with it, if it is the intention of the buyer to keep sheep at all. It would be madness to introduce a new unacclimatized flock to such land. This does not apply only to Louping Ill, but also to other disease of hill sheep. There is also the fact that native sheep learn to know their way about mountainous regions in a remarkable manner and tend to confine themselves to individual groups, which graze certain areas and never leave them. These groups are the " hefts " of the Scots shepherd. A lamb removed from a hill for some time and brought back again later will find its way to its own " heft " no matter on which part of the hill it is freed.

Prevention.

Having digressed considerably from the subject it remains merely to mention the means of prevention of Louping Ill, for cure there is none. Vaccination can be practised with a considerable degree of success. Where vaccination is being carried out for the first time the whole stock except very young lambs should be vaccinated. In subsequent years the previous spring's lambs should be vaccinated in March or, if they have been wintered away from home, fourteen days before they return. Some, in order to prevent losses of lambs which can occur in the autumn, vaccinate all ewe lambs which are to be retained in the flock in August and again the following spring.

Louping Ill can also affect cattle, horses, pigs and man, cattle the most frequently.

(iii)

Scrapie.

Scrapie, a disease of sheep almost certainly caused by a filtrable virus was, for very many years, a most baffling ailment. It is certain that it is contagious and since no bacteria have ever been found which can cause it, the only explanation is that the cause is a virus. It has been known in this country for more than two hundred years and at the present time it is most prevalent in the Border Leicester and Cheviot Breeds, in Border Leicester-Cheviot crosses and in cross Suffolks. The condition is found mainly where these breeds and crosses are the principal sheep, namely in the border countries of England and Scotland and in East Anglia. Isolated outbreaks may occur in other districts chiefly following the import of sheep from these areas.

Scrapie can be transmitted to the lamb from the ewe or even from the ram and it has been proved that it can be carried on pasture, a Scrapie-free flock grazing on pasture recently vacated by one suffering from Scrapie can become infected. This being so it is difficult to believe that direct transmission from one animal to another does not occur on occasion. A ewe or ram which transmits the disease to its lambs may never show any sign of the condition or it may develop the trouble late in life. Nine-year-old ewes have been known to be affected.

Very Long Incubation.

A remarkable feature of the disease is its very long incubation period. Infection under eighteen months of age is not known even when the disease has been derived from a parent. The most common time for its appearance in a ewe is at or about the time when she has her first lamb. The strain of lambing and of suckling the lamb seems to precipitate the onset of the disease.

Scrapie develops slowly. The experienced shepherd can usually see signs of the trouble before anyone else. Some maintain that the fleece is of a lighter colour but alterations in the sheep's behaviour are more characteristic. The animal becomes nervous and is easily startled. A fine trembling can often be seen affecting the head and neck which causes nodding movements. When an affected animal is hustled it seems to become stunned with excitement and apprehension and a trembling of the thighs and flanks can be seen. Such an animal may drop in a faint, only to recover later or die without gaining consciousness. The head and ears in some cases may be held in an unnatural position and when trotting there is a peculiar high stepping gait. Thirst is a common symptom and the quality of the voice becomes altered. Bleating is feeble and husky.

Outstanding Symptom.

The most outstanding symptom is the development of an intense itch which usually commences in the region above the tail and at length affects the whole body. There are no changes in the skin to account for the itch such as sores or scabs. The affected animal rubs itself constantly on posts, tree stumps, or anything that is available and the wool over the affected parts becomes loose and falls out. The incessant rubbing usually damages the skin. Although the appetite remains good the animal is unable to concentrate on grazing or to rest for any length of time because of the itch. In the later stages of the disease, sheep become extremely emaciated, almost denuded of wool and present a sorry sight. They ultimately die. Fits and convulsions are not uncommon when the disease is advanced.

Difficult to Eradicate.

In an infected flock the average number of animals with the disease at any time is ten per cent but up to twenty per cent may be affected. It is exceedingly difficult to eradicate the condition once it has become established in a flock and the best way to get rid of Scrapie is to slaughter all animals, rest the pasture, and start afresh from a source known to be disease-free. Scrapie pursues a slow insidious course and after death no changes indicating the presence of any disease can be found in the carcase. All organs and tissues are apparently normal. It is fairly obvious from the symptoms that the virus attacks the nerves and probably the brain.

(iv)

Pine or Pining.

There is a wasting disease of sheep found in certain areas of the country which has become known as Pine, Pining, or Vinquish. The cause is not a germ but deficiency or lack of a certain mineral in the soil and consequently in the pasture. The mineral is cobalt and just what its function is in the animal body is not known but it has been established beyond doubt that Pine is caused by a deficiency of cobalt.

Signs of the Disease.

Lambs begin to show signs of the disease after weaning. They become progressively weaker, lose condition and are anaemic and listless. The eyes become sunken, the fleece lustreless and there may be a discharge from the eyes. In general the animal's growth is markedly retarded and it is extremely unthrifty. Eventually if the disease progresses the animal is unable to rise and eventually dies.

What has been described represents the disease at its worst but the condition varies in severity in different areas. In some the sheep do not thrive as well as they might, whereas in others Pine can be a killing disease. All grades of the malady are found between these two extremes.

Similar Symptoms.

Two other diseases in particular also cause wasting in sheep, Johne's disease and parasitic worm infestation. Examination of carcases will usually establish the presence of these two

troubles, whereas Pine shows nothing on after-death examination to account for the condition. Worm infestation, which will be described later, can be present in a flock along with Pine and one condition aggravates the other. Pine affects sheep of all ages whereas worms cause disease usually in young sheep only. There may be some difficulty on occasion in differentiating the three diseases particularly when no carcases are available for examination, but consideration of the previous history of the flock along with apparent ineffective dosing for worms will usually enable a diagnosis to be made. If treatment for Pine gives results then the presence of that disease is established.

Treatment consists of either dressing the land or treating the animals with cobalt. The top dressing for pasture usually employed is cobalt sulphate at the rate of 2 lb. per acre.

(v)

Swayback of Lambs.

A rather similar disease to the last is Swayback of lambs. This is connected in some way with a deficiency of copper in pasture which, although it produces no symptoms, results in lambs being born with degeneration of certain parts of the brain. This causes a great weakness of the hind quarters of new born lambs. Deficiency of copper cannot be the sole cause since Swayback can be found on pastures wherein sufficient copper exists. Nevertheless administration of copper to ewes in many Swayback districts prevents the disease occurring in lambs.

Again, in this disease, animals are not all affected with the same severity. Some cannot rise, others do so with difficulty, some maintain balance only by straddling the hind legs whilst others show only a slight weakness. The number of affected lambs varies from year to year. All badly affected lambs die eventually, death being due to inability to keep up with the ewe and feed or because of disease resulting from exposure and malnutrition.

Swayback can be prevented largely by providing the ewes with salt licks containing one per cent of copper during the period that they are in lamb.

Like Pine, Swayback can be prevented by the administration of the merest traces of the element or substance which is deficient, therefore each of these diseases is an example of what have become known as trace-element diseases.

(vi)

Twin Lamb Disease.

Pregnancy Toxaemia is another disease of sheep affecting in-lamb ewes which is not as yet properly understood. It is also known as Twin Lamb Disease since it is almost wholly restricted to pregnant ewes carrying twin or triplet lambs. Occasionally it is found in animals with single lambs, but it never occurs in non-pregnant animals. It appears during the last fourteen days of pregnancy particularly following a period of rough weather. A fall of snow has been long associated with the condition and it would seem that the resulting limitation to feeding and the decrease in exercise taken by the ewe have an influence on the development of the condition. It is known to be due to an upset to the way in which the body utilizes food, products being formed which are abnormal and which have a poisoning effect on the animal. The disease is found throughout the world wherever the sheep industry is carried on and varies greatly from year to year in its prevalence depending largely on climatic conditions.

Symptoms.

An affected ewe separates herself from the flock, appears dull, carries the head in an unnatural position to one side or very high, and she often lies for long periods and staggers about when moved. Constipation is usually a feature of the condition and the appetite is lost. Within a few days the ewe becomes unable to rise and is only half conscious. Eyesight is affected and some apparently become blind. A fine trembling may be noticed in the region of the head and neck and this may extend to the whole body. Rumination ceases and the abdomen may be greatly swollen with gas. At the end the animal becomes completely unconscious, lies on her side and dies within one to six days of the onset of the disease.

Only those ewes which are affected very close to lambing time have a chance of recovery, for the act of lambing relieves the condition. About ninety per cent of affected ewes die.

Examination of Carcase.

Examination of a carcase after death show only one notable change. The liver has become very fatty. It is yellow in colour and very fragile; the fingers can be pushed into it with ease. Fatty liver is a usual condition found in pregnant animals but in Pregnancy Toxaemia this change is much further advanced.

For many years Lambing Sickness was confused with this condition, the former being, the reader will remember, identical with Milk Fever of cows. Since Lambing Sickness occurs in ewes before lambing it appeared at the same time as Pregnancy Toxaemia and the two conditions were thought to be one and the same. Now however they are recognized as separate diseases and Lambing Sickness can be cured.

So far, treatment of Pregnancy Toxaemia has shown little success. Injections are given which, in some cases, seem to have a good result. It is thought by some that control of diet succeeds to some extent in preventing the disease, particularly the feeding of roots. Experienced shepherds maintain that forced exercise of the ewe flock will act as a prevention; pregnant ewes are driven slowly over the distance of about one mile daily during the last three weeks before lambing.

DISEASES CAUSED BY PARASITES

The condition of parasitism is discussed here and a number of ailments caused by parasites are described. Redwater, an important disease of cattle receives attention. The life histories of a number of flies are described, because their young feed upon living animals. These are the Sheep Maggot Fly, the Sheep Nostril Fly, the Ox Marble Fly and the Horse Bot Fly. A description is given of Scab of Sheep and Mange of other animals. Lice, Fleas and the Ringworm Parasite receive brief attention.

(i)

Parasites.

THE reader will find that the rest of this section is devoted to a description of the forms and habits of a selected number of parasites which prey upon animals. The subject of parasitism is an interesting and intriguing one since many creatures which have this mode of life are wonders of adaptation and exhibit varied means of development which are nothing short of amazing. In the marvels of the animal kingdom the methods of the reproduction, growth and general habits of these objectionable beings must occupy a prominent place.

Parasites are living things which subsist at the expense of other creatures, their hosts; parasitism is to the benefit of the parasites and to the detriment of the hosts. One form of life can live in or on another without doing damage; such is not a parasite in the true sense of the term. It is possible also for living things to exist in close association with each other and for both to derive benefit; again, one may benefit but not the other; however the one that does not benefit suffers no harm. The essential part of the condition of parasitism is that the host suffers damage in some way. It is almost certain that animals that we know to-day as parasites lived at one time free lives and that they gradually adapted themselves to the parasitic state.

Complicated Cycles of Development.

Some parasites, such as lice, live their whole lives as such but others only spend part of their existence as parasites; for example the sheep blow-fly or maggot fly which lives a free life lays its eggs on sheeps' wool and the larvae (i.e. grubs) which hatch from the eggs live on the sheep. Some parasites have most complicated cycles of development. They progress through different stages and at length attain the mature adult form. The successive stages, from egg to adult are known collectively as the life cycle.

In a sense, disease bacteria can be considered as parasites because they exist in and live at the expense of the animal body. However, it has become customary to restrict the term to the higher forms of life which subsist in this way.

In the study of bacterial diseases it was noted that certain bacteria tended to attack certain parts of the body. Parasites behave similarly. And, also like bacteria, certain species of parasites will attack only certain animal species. For instance the dog flea is a different species from the human flea and although most animals can be infested with lice, for the most part each animal has its own species.

In general, the development of actual disease following infestation with parasites depends upon the number of parasites present in or on the host. A few worms present in the intestine of an animal may do that animal no harm but when they become numerous grave symptoms and even death can result. Of course it is not in the interest of any parasite to cause the death or even the serious illness of its host. Death of the host means the end of the parasite and under natural circumstances this unfortunate event would not occur nearly so frequently as it does with untreated domestic animals. In the majority of cases it is when animals are crowded together that parasites become so numerous in individuals that disease is set up, so that, in this sense, many parasitic diseases are man-made.

How Do Parasites Injure Their Hosts?

Now, how do parasites injure their hosts? Their is a number of ways in which this comes about. They may suck blood or consume some other body tissue; they may cause harm by obstruction to or pressure upon some important organ. They may consume or absorb food meant for the host and they may wound or irritate. It is almost certain also that some internal parasites produce toxic substances which have an adverse effect on the host. Last, but by no means least, certain parasites transmit disease. We considered an example of this in louping ill of sheep carried by the tick when dealing with a group of diseases in pp. 476–479. The life history of the tick has already been described there and it remains only to give some account of other animal diseases which are transmitted by that parasite.

(ii)

Tick-Borne Fever.

In sheep there is a condition called Tick-borne Fever which is not in itself very important, but which may so lower the resistance of animals infected that they become temporarily susceptible to other disease conditions. Sheep are rarely if ever very ill when attacked. The germ is inoculated by the bite of the tick and the infected animal shows a rise of temperature for a day or two but after that the disease subsides.

Ticks also are held responsible for infections of young lambs which are very serious in some areas. The germs which are commonly associated with suppuration and the development of abscesses, *staphylococci*, are transmitted from lamb to lamb by tick bite. Abscesses form in the joints and in other parts of the bodies of lambs and those affected usually die. There is as yet no

successful method of coping with this condition other than by attempting to control tick infestation.

Red Water.

Red Water, a very important disease of cattle in some areas, is transmitted by ticks. The germ of the disease attacks the red corpuscles of the blood so that it is in some ways similar to malaria of humans which results from a similar attack by a germ carried by a biting mosquito. Red Water mainly attacks adult cattle. It follows the bite of an infected tick and sometimes the disease appears some considerable time after the bite has taken place.

The germ of the disease is not a bacterium; it is a protozoon parasite. Such have been mentioned before as being the smallest form of animal life, a previous example being that which causes *Trichomonas* disease of cattle. In Red Water we have an example of one parasite, the tick, transmitting another, called *Babesia*, the actual cause of the disease. These organisms, introduced into the bloodstream of cattle by the tick, penetrate the red corpuscles of the blood. There they commence to multiply to such an extent that eventually they rupture the corpuscles, and their haemoglobin is released into the fluid part of the blood. The haemoglobin is excreted by the kidneys and gives a red or dark brown colour to the urine, hence the name Red Water. An intense anaemia results in badly affected cattle and many die.

The first symptoms are a very high temperature and diarrhoea though later on severe constipation is a feature of the disease. The coloured urine appears some twenty-four hours after illness begins. The animal wastes very quickly and ceases to feed. An outstanding symptom is a very loud and accelerated heart-beat which can often be heard some distance from the animal.

Resistance.

Animals reared in Red Water districts usually acquire a fair degree of resistance to the condition while they are still young. If they happen to become affected the disease pursues a mild course and they recover; nevertheless the disease parasites persist in the blood in small numbers so that such animals are reservoirs of infection and the disease can be transmitted from them to others by ticks. Such cattle are called " carriers." Any upset to carriers which lowers their resistance may precipitate an acute attack; for example, following a journey or after calving an acute attack may set in.

Nowadays useful drugs are available for the treatment of Red Water but, as in other conditions, treatment must be carried out early in the disease.

(iii)

Sheep Blowfly.

Of the external parasites which plague animals one of the commonest and one of the most serious is surely the maggot of the Sheep Blowfly. This fly is very familiar to our sheep farmers; it resembles the common Blue-bottle but is rather smaller and of a greenish metallic colour. Wherever there is carrion it is to be found in large numbers in association with the blue-bottle and other likeloathsome insects.

The sheep blowfly lays its eggs either on carrion or on living sheep. In the sheep's wool the eggs may be found in clusters especially from May to September although the fly may be active earlier or later in the season than this according to climatic conditions. A group of eggs laid in the wool is termed a " blow " and when larvae (i.e. maggots) hatch from the eggs a " strike " is formed. Upon hatching the maggots commence to eat through the skin and burrow their way into the tissues. After feeding for two or three days the maggots drop off the sheep on to the ground. There they surround themselves with a hard resistant covering, and are said to pupate. Within the resistant covering the maggot undergoes further development and change and eventually emerges as an adult fly. If it is a female, it proceeds to lay its eggs on sheep.

Once a strike has developed others follow it in rapid succession. The odour attracts more flies and eggs are hatching almost constantly, adding to the number of maggots, until the sheep is literally eaten alive if it is not attended to. All " blows " do not develop into " strikes." The necessary condition of moisture must be present in the sheep's wool to enable the eggs to hatch. Also some sheep seem to be much more susceptible to maggot infestation than others, this difference applying to individuals rather than to breeds. Soiling of the wool by dung or other matter attracts the fly. In every flock one or more animals will be found which are attacked again and again by maggots throughout the summer. By far the greatest proportion of the shepherd's time is occupied in this season by constant inspection of sheep for cases of " strike."

Major Disease Problem.

Blowfly " strike " constitutes the major disease problem among sheep in summer. It is found throughout the country and even hill-sheep grazing at considerable altitudes are not free from this pest. In parts of the western Highlands of Scotland the condition has become a menace to the sheep industry, and when one considers the inaccessibility of sheep in these areas the difficulties of the hill shepherd will be readily realized.

So far there has been no satisfactory method of controlling blowfly " strike." Dipping of sheep with any of the proprietary dips seems to confer some protection but this lasts only for a short time. However, new insecticides which have come to the fore recently seem to show considerable promise when used as dips and it may be that the problem of the blowfly is nearing solution.

Treatment.

Treatment of "strike" consists of clipping the wool on and round the affected area, and picking out the maggots, which should be destroyed. The part is then dressed with one of the proprietary preparations in an attempt to repel further attacks by the fly.

(iv)

Sheep Nostril Fly.

Another species of fly, the maggots of which attack sheep is the Sheep Nostril fly. The female of this species does not lay eggs but gives birth to living larvae or maggots which are deposited in or near the nostrils of sheep. The fly is active during the warm months of the year and sheep often show considerable annoyance at the presence of the fly. They rush about with their noses down and rub their noses on the ground or with their feet. Young sheep are most commonly affected.

The maggots crawl up the nostrils of sheep and occupy certain of the bony spaces in the head which are connected with the nasal cavities. There are three stages in the development of these maggots and each stage is spent in a different region of the sheep's skull. During warm weather the maggots can reach complete development in about four weeks but at other times as long a period as eleven months may be spent within the sheep's head. On reaching maturity the maggots drop from the nostrils or are sneezed out; they pupate on the ground and emerge as adult flies in from three weeks to two months; the length of time again depends upon conditions of warmth.

Unless infestation with such maggots is heavy, sheep show little or no discomfort. Nevertheless when many maggots are present a nasal discharge may appear. In rare cases maggots have been known to penetrate to the brain where they have caused serious symptoms.

There is no satisfactory method of treatment of this condition. In areas where it is prevalent a strip of pasture is sometimes ploughed to provide loose soil in which sheep can thrust their nuzzles when the fly is in the vicinity. Also oil of pine-tar may be smeared on the nostrils to act as a fly repellant.

(v)

Ox Warble Fly.

A serious disease of cattle from the point of view of damage to the skin and therefore to hides is that caused by the larvae of the Ox Warble fly. This insect is large and has a certain resemblance to the common wild bee (Bumble Bee) having bands of yellow across its body. It does not feed; the sole mission of the female is to lay eggs. These eggs are to be found almost anywhere on the undersides of the bodies of cattle and on the legs. The fly is most active in warm sunny weather. It dislikes wind, rain or shade and will not follow cattle into or over water or into a shed.

"Gadding."

It is a remarkable thing that the presence of the warble fly in the vicinity induces in cattle a state of terror; no pain is felt by these animals when the fly alights on them. It is incapable of biting or stinging and it would seem to be impossible that cattle realize that the maggots which hatch from the fly's eggs penetrate into their bodies. Nevertheless when the buzzing of the warble fly is heard cattle stampede; they run aimlessly about the pasture with their tails elevated. This is known as "gadding" and the fly is sometimes called the gad fly.

The eggs which are laid on cattle hatch in about seven days and minute larvae emerge. They crawl down the hairs to the skin and bore through it to reach the tissue immediately under the skin. For a period of about three months these little maggots wander about the body, always just under the skin, in the regions of the legs, chest and abdomen and eventually they proceed to and arrive at the wall of the gullet or oesophagus. They penetrate into this and, remaining in the oesophageal wall, they travel along this organ through the chest until they reach the diaphragm. The route which the maggots follow from this point is not properly understood but they arrive eventually under the skin of the back where they are to be found from the middle of February onwards. In this situation they bore a hole through the skin to breathe. Round each maggot in the animal's back an inflammatory swelling develops and this results in a distinct lump which can be readily felt by running the hand along the backs of infested cattle. Such a lump is known as a warble. Throughout the period of its wanderings in the body of cattle the maggot has grown considerably and by the time it reaches the back region it has increased its size many times. About ten weeks are spent under the skin of the back after which the maggot, now one-half inch or more in length, emerges through the hole in the skin and drops to the ground. There it pupates to become a fully-developed fly in about six weeks time. Most of the flies attain complete development during the months of June and July so that the Ox Warble Fly is most common during these months. The females proceed to lay eggs on more cattle and so the cycle goes on.

Economic Importance.

The wastage caused by the activities of warble fly larvae are of very great economic importance. The "gadding" of cattle results in loss of flesh and reduced milk yield. The migrations of the larvae within the body render considerable portions of meat unsuitable for human consumption. The tracks left by their wanderings become filled with a jelly-like substance and they have to be cut out by the butcher. Serious injury to the oesophagus sometimes results when many larvae have passed along its walls. Last but not least, not only are the warble swellings painful to the

animal but the tanning industry has a definite objection to hides perforated in a number of places by the action of the larvae.

Control.

It will be realized then, that control of infestation by maggots of the warble fly is of great importance. Since this fly can produce itself only by the means described, it would seem that it is particularly vulnerable to attack, and if all maggots present in warbles could be killed the fly would cease to exist. Some parasites are more easily controlled than others because at a particular stage in their life-cycles they are more susceptible to killing agents. The ox warble maggot provides a good example of this, in that it can be killed while in its position under the skin of the back.

Theoretically if all cattle in the country were dressed adequately with the proper preparation and if this were done at the proper times the warble fly would disappear. It is known that washes containing derris powder will kill the larvae and such dressings can be purchased ready for use after mixing with water.

In an effort to eradicate the warble fly the Minister of Agriculture made an Order in 1936 requiring all owners of cattle which were visibly affected with warbles to start treatment with derris, the dressings to commence between 15th and 22nd March in each year or as soon as warbles appeared. The application was to be repeated at intervals of not less than twenty-seven days and not more than thirty-two days as long as warbles continued to appear but not after June 30th. Unfortunately owing to the fact that derris was unobtainable during the war the Order had to be suspended, but is now again in operation.

Because infestation with warble maggots is of such importance one would think that all owners of cattle would welcome any attempt to eradicate the pests be it compulsory or otherwise; it is to be feared however that some prefer warbles to the expenditure of some time and labour towards their eradication. Unless measures of eradication are applied conscientiously and adequately by all, without exception, they must necessarily fail to achieve their purpose. Failure of a few to carry out such obligations means sabotage of the endeavours of many.

(vi)

Horse Bot.

Horses are not immune to attack by fly larvae. The horse bot fly maintains its existence by utilizing this animal as host for its larvae. The female fly lays its eggs singly and attaches them to hairs covering such parts of the horse's body as are easily reached by its mouth, for example the fore limbs or chest. Each female fly lays, in all, four hundred to five hundred eggs, but only one is laid each time the fly settles on a horse. This pest is most prevalent during the height of summer and in early autumn. It is supposed that the eggs or larvae cause a tickling sensation on the horse's skin, for infested horses continually nibble and lick at the part where the eggs are. Thus the tiny maggots which hatch from the eggs become attached to the horse's tongue, are swallowed, and reach the stomach. There the larvae attach themselves to the lining of the stomach and remain there for ten or eleven months growing and developing all the time. In spring and early summer they become detached and then pass with food from the stomach into the horse's intestine; they traverse the full length of this organ and emerge from the body with the horse's dung. On reaching the ground the larvae penetrate loose soil and pupate. They emerge as flies in from two to three weeks. Then the cycle starts again.

Unless present in very large numbers horse bots do not seem to upset horses in any way. Their presence is usually unsuspected until they are observed in the dung. In isolated cases obstruction of the intestine has been caused by very large numbers of such maggots and very occasionally the stomach wall has been perforated and peritonitis has resulted.

Bots are very difficult to kill or to expel from horses by the administration of drugs.

(vii)

Scabies. Sheep Scab.

There is an external parasite which is the cause of a severe skin disease which can attack all domestic animals and man himself. The general term for the condition is mange but in humans it is called Scabies and in sheep it is termed Sheep Scab. The disease is very contagious and passes readily from animal to animal of the same species and can be carried by any article or material which has been in contact with a diseased part. In general, unhygienic conditions and neglect of animals contribute to the development and spread of mange although it must be understood that the actual cause of the condition, the mange mite, must be present as well.

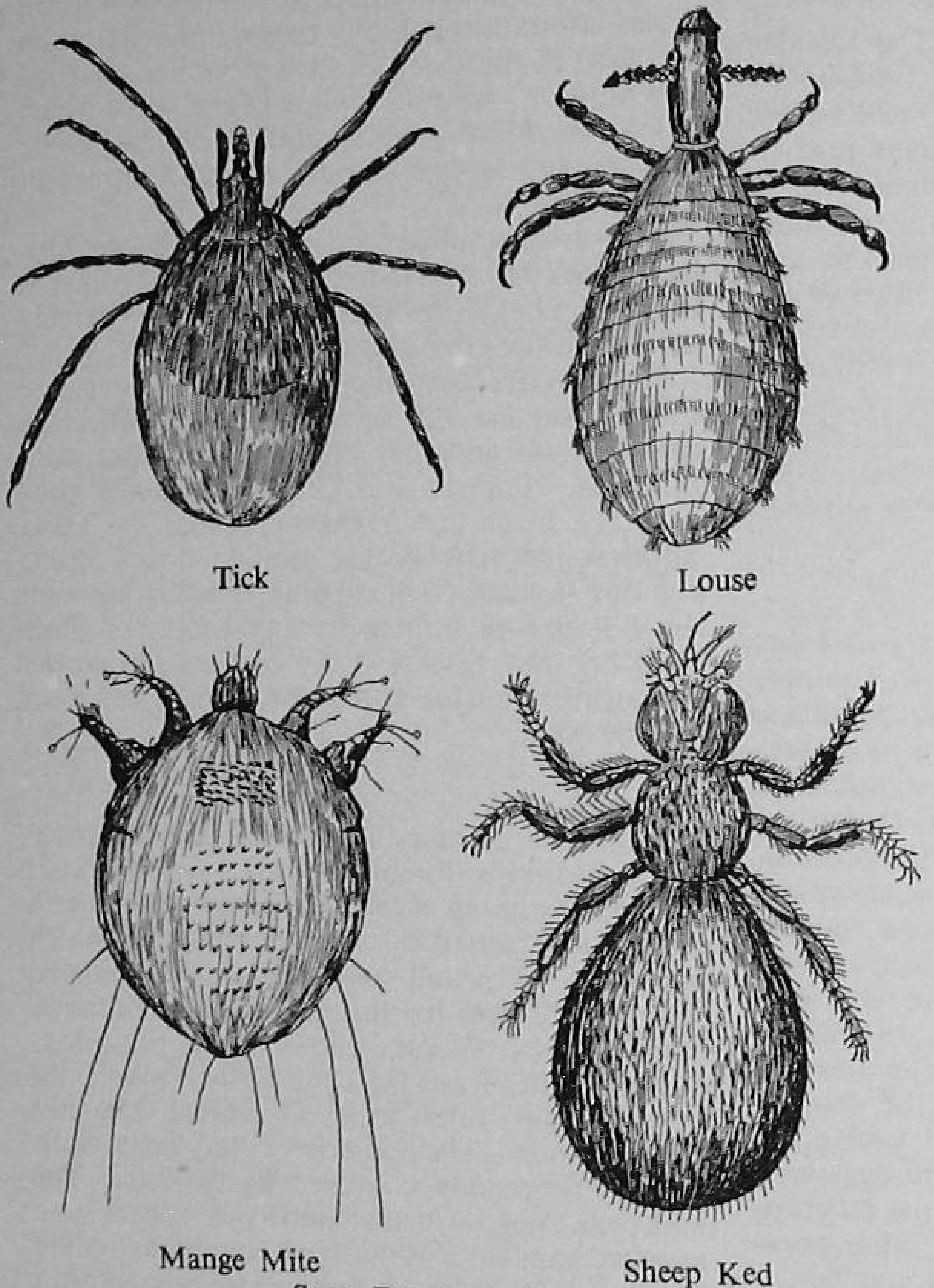
Mange mites are tiny parasites, for the most part only just invisible to the naked eye. One species can be seen as a minute grey speck by the unaided eye. They have well defined bodies and legs and are capable of movement. A number of species affect animals and a different variety of each species attacks each different animal. This is why horses cannot affect dogs or cattle or any one animal pass the disease to another not of the same species. There are exceptions to this however in that one form of cat mange can attack humans and it is reported that certain types of dog and horse mange can also do this.

Mange mites live on and sometimes within the skin of the host. They cannot exist for long in other situations and they spend the whole of their lives as parasites. The females lay their eggs on or within the skin, different parasites differing in this respect. One species bores its way vertically into the thickness of the skin and lays its eggs in

clusters at the base of the shaft thus formed; another species burrows channels in the skin which are parallel to the skin surface and the eggs are strung out along these channels. When the eggs hatch a larva or grub emerges and this, after certain stages of development similar to those of ticks, becomes an adult male or female. However mites do not leave their hosts as ticks do during the successive periods of development.

Irritation.

The habits of mange mites are such that they



Some External Parasites

cause extreme irritation and itching of the skins of their hosts. The mouth parts of the parasites are thrust repeatedly into the skin and they feed on the juices contained therein. At the same time an irritating fluid is injected into the punctures which gives rise to a small pimple, red at first. Fluid is exuded from the spot and when many parasites are at work this causes hairs to become glued together and matted. At a later stage the hairs fall out and the skin becomes markedly thickened and scaly. The constant irritation and itching set up cause the affected animal to scratch frequently at the part and to rub its body against any available object. The scratching and rubbing result in further damage to the skin and accelerate the loss of hair. The consequent restlessness of affected animals and their inability to concentrate on feeding very frequently makes them lose condition and quite rapidly when the disease is extensive.

Skin Dressings.

Almost all cases of mange can be cured by the application of appropriate skin dressings. Treatment may be protracted and will depend for its success on perseverance with the remedy. Unfortunately some of the lotions used are of an offensive nature and have an unpleasant odour and this, on occasion, may prevent their being applied as frequently as they should be.

Mange in sheep or sheep scab is a notifiable disease and for this reason the dipping of sheep has been made compulsory in this country. Double dipping is carried out in certain areas, all animals being dipped twice, with a definite interval of time between each dipping. Such double dipping is obligatory where the disease exists. The first dipping kills all mange parasites but not their eggs. The second dipping is timed to take place when all eggs have hatched but before any of the newly hatched mites have reached maturity. This means that no further batches of eggs will have been laid.

Despite these measures which were designed to eradicate sheep scab from this country the disease still exists and is most frequently found in hill areas. The reason is that it is almost impossible to dip all sheep without exception in the inaccessible hills. In the general round-up for dipping a few animals are often missed and these serve to perpetuate the disease.

"Itchy Leg."

A common mild form of mange which is present in horses is known as "Itchy Leg." Its presence in horses makes them restless when in the warmth of the stable; they stamp and kick frequently. This form of the disease never attacks the body of the animal, only the legs. It can be cured much more readily than some other types of mange.

(viii)

Lice.

All domestic animals can, on occasion, become

infested with lice. These parasites are common on pigs and cattle, and dogs are not infrequently attacked. Some lice suck blood, others do not, but all give rise to extreme irritation of the skin. Consequently affected animals are restless, scratch a great deal and are constantly rubbing themselves against different objects. A heavily infested animal will not thrive. There are many species of lice each will infest only one host. Thus three species attack horses, four are to be found on cattle, two on sheep, two on goats, two on dogs but pigs and cats are each infested by one type only.

Simple Life History.

Lice have a simple life-history. The females lay eggs or " nits " which are glued to the animal's hairs. The eggs hatch in from one to two weeks, the time differing according to species and to atmospheric temperature. The larvae which emerge feed and grow and undergo three moults before reaching the adult state. After this and within a few days the females commence to lay eggs. The time taken to attain complete development differs with the different species of lice. As an example, the complete life cycle of one of the common lice which affect cattle is twenty-eight days. Lice are strict parasites. They survive only for a matter of hours after removal from the host.

Dirt and Neglect.

It cannot be emphasized too strongly that dirt and neglect contribute considerably to the persistence and multiplication of these parasites. Also, it has been shown that lice are most prevalent in cattle at times of the year when nutrition of these animals is at its lowest. Therefore in treatment as well as in prevention, cleaning, thorough and adequate grooming and adequate feeding are important. With respect to specific treatment lice are comparatively easily killed but their eggs are very resistant to the action of destructive agents that can be applied with safety to the bodies of animals. Therefore most dressings have to be applied twice, the second application being carried out some twelve to fourteen days after the first so that all eggs will have hatched but females will not have reached maturity. Thus no more eggs will have been laid. It is almost certain that the new insecticide D.D.T. will prove to be as effective against lice in animals as it is in humans. Owing to the persistent action of this product one dressing only is necessary.

Lice are not known to carry disease in animals in a way similar to that by which they transmit typhus of humans.

The Ked.

A particularly troublesome small crawling crab-like parasite that is to be found on sheep is the ked. It is really a degenerated wingless blood-sucking fly which spends its whole life on sheep and sheep only. It cannot exist on any other host and it survives only for a few days when off the sheep. Female keds do not lay eggs but give birth to fully developed larvae enclosed in a sticky covering which becomes attached to the fleece and hardens within a few hours. A mature ked emerges from this covering in from nineteen to twenty-four days.

Ked infestation is at its heaviest in spring and the numbers on adult animals decrease progressively throughout summer. Lambs on the other hand become increasingly infested during that time. Shearing removes practically all keds because they remain attached to the shorn wool. When infestation is heavy considerable irritation is caused to the sheep and the wool has a ragged appearance. Also the soiling of the fleece which follows incessant rubbing and scratching, along with some staining by blood, act as an attractant to the blowfly.

Keds are not killed by the common sheep dips. Derris powder mixed in a dip or used alone is effective. D.D.T. has been shown to be extremely efficient in the eradication of keds.

Probably the best known parasitic insects are fleas. They are not of importance as affecting farm animals and they attack mostly dogs, cats and man. Puppies and kittens may suffer considerably from the irritation caused by these parasites and may become debilitated as a result. The dog flea although capable of attacking man will not remain on him for any length of time. Fleas lay their eggs in dusty corners and cracks in flooring. Larvae hatch out, pupate and then become adult.

Ringworm.

Ringworm, another important external parasitic condition, still remains to be mentioned. It has no connection with those already dealt with because it is caused by a mould or fungus which attacks the skin and hairs, forming a rounded raised patch, often hairless, and this area becomes dry and scaly. Horses, cattle, sheep, pigs, dogs and cats suffer from the condition although, for the most part, one species of animal does not affect another. The condition is very contagious and can be readily conveyed by contact. The ringworm fungus forms numerous spores and these are capable of setting up the disease when they become lodged on another animals. Man can contract the condition from cattle.

Ringworm is very prevalent in young stock, particularly young cattle and once it makes its appearance it is extremely difficult to eradicate completely because the spores persist for a considerable length of time. The disease seems to make headway most readily in undernourished animals.

There are a number of applications which can be used to cure ringworm, preparations of mercury possibly being the most common. When infestation is severe a long course of treatment is sometimes necessary.

DISEASES CAUSED BY PARASITES (Cont.)

ROUND-WORMS.

Round-worm infestation is probably the most common cause of unthriftiness and stunted growth and even of serious disease in farm animals. A description is given of the methods by which numbers of these parasites reproduce themselves, gain access to the host animals and cause disease. Particular attention is paid to worm diseases of sheep and cattle because of their extreme economic importance in these animals. Thus parasitic worm infestation of the digestive system and "Hoose" or "Husk" are dealt with in some detail.

Round-Worms.

THE most common parasitic condition in animals is infestation with round-worms. These are cylindrical in shape with more or less pointed ends and so differ markedly from tapeworms which are flat and ribbon-like. Different species of round-worms are of different sizes; for instance some of those which commonly attack sheep are not more than one-quarter of an inch in length and are as thin as a fine thread, whereas certain worms found in pigs are eight or nine inches long and as thick as a lead pencil. Most round-worms inhabit the stomachs and intestines of animals but some species live in other parts of the body. None multiplies within the body of the host, some part of its existence being passed in another situation. Both male and female worms exist as separate individuals, the ovum or egg of the female being fertilized by spermatozoa from the male. All species of animals may harbour round-worms; each species of worm however will, as a rule, infest only one animal species. For instance those which live in cattle cannot exist in horses. There are exceptions to this however, and so certain worms which infest sheep can also attack cattle.

Degrees of Severity.

Sheep are the principal sufferers from round-worm infestation. Lambs are particularly susceptible and they may carry a burden of worms numbering many thousands. Severe infestations will cause extreme emaciation of lambs and death commonly results. Apart from this all degrees of severity of infestation are found; there are times when little or no trouble is caused while at other times lambs do not thrive as well as they should although they do not become actually ill. In severe cases almost constant symptoms are diarrhoea accompanied by wasting. Affected lambs lag behind the rest of the flock and become progressively weaker.

The Twisted Wireworm.

The parasitic round-worms which commonly affect sheep are mostly very small; some are less than one quarter of an inch in length. One however, *Haemonchus contortus*, the twisted wireworm, may be an inch or more in length and it is the most injurious of all the species. It inhabits the abomasum or fourth stomach of sheep and is a voracious blood-sucker. Sheep affected with this parasite show a considerable degree of anaemia and animals which receive a sudden and very heavy infestation may die quickly without showing other symptoms. In addition to the twisted wireworm other species infest the abomasum, and the small intestine also is the habitat of a number of species. When examining carcases of sheep which have died from worm infestation it is quite common to find more than fifty thousand of these parasites present and infestations of one hundred and fifty to two hundred thousand are not unknown.

Life History.

The life history of sheep round-worms is simple in that there is direct development from egg to adult worm, male or female. The females lay large numbers of eggs within the sheep and these are passed out on to pasture in the droppings. It has been estimated that a healthy sheep which harbours a number of such worms may pass on to the pasture between two hundred thousand and four hundred thousand worm eggs daily. On the other hand a sheep which is diseased because of a heavy worm infestation may deposit from nine million to thirty-three million eggs every day. This prolific rate of reproduction is commonly found to exist among parasites and other forms of life where the chances of survival of the offspring are few. Not all eggs will hatch and many of the larvae which emerge from the eggs will not survive. Nevertheless a very high rate of pasture contamination with worm larvae is usual where worm infestation of some degree exists among the grazing animals. As has been said worms do not multiply within the animal; every one which is present in the stomach or intestine must have been picked up with food while grazing.

Correct Conditions.

In order to develop on the pasture the worm-eggs require the correct conditions of heat, temperature and moisture and the larvae which hatch out must have similar conditions in order to reach the stage of development at which they are capable of infecting sheep. The newly-hatched larva, if taken up by a grazing host, is unable to persist in the host. All larvae must pass through certain stages and become what are known as "infective larvae." Then, and only then, are they able to develop into adult worms if consumed by a sheep. The time taken to reach this "infective" stage is about four or five days but when climatic conditions are not of the best, from the point of view of parasitic worms, the average time taken for the egg to develop to the

infective larva stage may be much longer. Periods of drought will reduce markedly the rate of development—in fact in such conditions eggs may fail to hatch at all. However this temporary relative freedom of pasture from maturing larvae may not be altogether a good thing; when rain comes the very large numbers of eggs which have accumulated may all hatch at once to be followed by an extremely heavy pasture infestation with infective larvae. The result may well be sudden and a very acute worm infestation of the grazing stock may supervene. Again, in drought, sparse pasture may result in both close grazing and in grazing over a wide area and this will increase the chance of animals picking up the larvae.

Pasture Contamination.

The question is often asked as to how long a pasture remains dangerous from the point of view of worm infestation after all host animals have been removed. It is known now that most pasture larvae have a comparatively short life; only those in the best situations, where they are protected, particularly from drying, are likely to remain alive for more than three or four weeks. Some few may persist for upwards of one year but these are unimportant, for pasture quickly becomes contaminated again by adults which carry worms. The progress of pasture contamination during any one year comes about in the following way. At the beginning of the season, before lambs are born, there exists on the grass a small number of larvae which have survived the winter. However, these are not important because adult sheep act as carriers of worms and they may harbour them in considerable numbers without showing any signs of illness. Therefore the droppings of the ewes deposit on the pasture numbers of worm eggs. Then, to quote an expert on the subject, "worm-free lambs are born into a 'wormy' world" and, as soon as they commence to nibble at grass, infestation commences. Because lambs are particularly susceptible, worms thrive within them so that grass becomes more and more contaminated with worm eggs and the lambs consume infective larvae in ever-increasing numbers. Thus, were it not for other factors which limit the extent of infestation, it would be impossible to rear young sheep on most lowland pastures.

Nutrition.

Perhaps the condition which has most influence on the development of heavy worm infestation in lambs is their condition of nutrition. If a lamb be nourished adequately, it is capable eventually of overcoming even relatively heavy infestations and it is known that, in time, a definite resistance is acquired against further attacks by worms so that a certain number will be harboured, but no more. However to reach this state of toleration, a lamb must be well nourished so as to be able to resist worm attacks in the meantime. Nevertheless if a lamb harbours very many worms, good feeding will not stop the onset of symptoms.

It is unfortunate that the period of maximum numbers of infective larvae on pasture should coincide with that of decrease of quality and quantity of the pasture and to some extent with the set-back which lambs may receive at weaning time. Pasture deteriorates progressively from early summer onwards and at the same time the numbers of infective larvae on pasture steadily increase. Thus lambs may receive the heaviest infestations when they are least able to withstand them. However, where nutritional requirements are adequately satisfied and where infestation with parasitic worms is moderate, lambs will usually overcome infestation to the extent of reaching a toleration level. Nevertheless it seems certain that, where there are tremendous numbers of infective larvae present even the most luxuriant pastures will not prevent the onset of parasitic disease such as is to be found in lowland pastures of excellent quality which are heavily stocked. Most flock-owners realize that the more lambs that are grazed per acre of pasture the more readily will they succumb to worm infestation. This fact cannot be emphasized too strongly and it will be readily understood that the greater the number of animals picking up worm larvae the greater will be the number of female worms reaching maturity and laying eggs in enormous numbers. Theoretically if the number of lambs grazing on a pasture be doubled then the rate of pasture contamination with worm-eggs will also be doubled. This will result in the grazing animals taking up twice as many larvae as they did originally and the egg output of each individual animal will then be increased two-fold. Thus the "build-up" of pasture contamination will progressively increase until serious trouble among the grazing animals results.

Resistance.

The resistance to worm infestation which is acquired by adult animals is not absolute. Ewes when under the strain of lactation have been known to become seriously ill and even to die from heavy infestations with *Haemonchus contortus*, the twisted wire worm.

Where the practice of folding sheep is carried out the possibility of worm infestation is not eliminated. If animals have a "run back" over ground that has been grazed more than three days previously there is a possibility of infective worm larvae being picked up there. Some experienced shepherds dispute this however; they maintain that animals do not attempt to feed on the "run back" but only go there to rest. Again, if lambs are folded over the same land twice within a period of six months or so, as is sometimes done, the contamination resulting from the first period of grazing may result in numerous larvae being picked up during the second period.

Serious worm infestation rarely arises where sheep are grazing over large areas such as on hill pastures, for the obvious reason that larvae are spread over such a wide area that the chance of their being picked up by sheep is minimized. Such sheep also carry few worms. The same effect can be had on lowland pastures by frequent moving of sheep to fresh land, every few days, provided that the cycle of movement is not repeated within three or four weeks.

Symptoms.

The symptoms exhibited by sheep seriously affected with worms are easily recognized. If wasting is accompanied by diarrhoea it is almost certain that parasitic worms are the cause. It must be remembered of course that Johne's Disease of Sheep may give rise to similar symptoms and Pine or Vinquish can cause marked loss of condition but not " scouring." It is rare to find only a few lambs of a flock visibly affected with worms; usually a large proportion exhibit signs of the disease. Diagnosis is sometimes more difficult where only the symptom shown is some retardation of development—lambs do not thrive as well as they might. If this should occur at the same time as a decrease in the level of nutrition then the fact that worm infestation is causing trouble may remain undetected. Examination of samples of dung in the laboratory for the detection of worm eggs will help in forming an opinion as to whether worm infestation can be incriminated to any extent.

Various Theories.

Why parasitic worms in the abomasum of sheep and cattle should have such serious effects on the health of these animals is not yet properly understood. Various theories have been advanced and it seems to be reasonably certain that a considerable upset to digestion, and therefore to the utilization of food, takes place. It is a notable fact that the worms, although in intimate contact with the digestive juices of the stomach and intestine, are not themselves digested. From this it appears to be likely that stomach and intestinal worms produce a substance which neutralizes the effects of the digestive juices and so the worms are protected. If this be so it is very probable that the neutralizing effect reduces the ability of digestive juices to digest food and so the animal does not obtain the full benefit from what it eats. Apart from this there is the possibility that parasitic worms produce a toxic substance which is injurious to the host. Of course, with respect to a parasite like *Haemonchus contortus*, which is an active blood sucker, much damage can be done to the host by this means alone.

Phenothiazine.

Fortunately round-worm infestation of sheep and lambs can be treated with a great degree of success. Until comparatively recently the most effective measure was dosing with a mixture of nicotine sulphate and copper sulphate (bluestone) in solution. This, although effective against most species of parasitic worms in sheep had the disadvantage of being very dangerous if given in too large a dose. Nicotine is a deadly poison and the dose necessary to kill and expel the worms was very close to one that might kill the animal. Consequently great care was necessary in the administration of this form of worm drench. Copper sulphate solution alone has been used and is most effective against *Haemonchus contortus* and copper sulphate mixed with arsenic is not without value. At the present time however the drug which is generally used is phenothiazine. It is extremely effective against sheep round-worms, is easily administered, and after extensive experimental trials and unrestricted use by farmers not one authenticated case of poisoning of sheep or lambs by its use has come to light. Phenothiazine is easily administered to sheep whether in the form of tablets or mixed in water as a drench. Every member of an affected flock should be treated whether there are visible signs of infestation or not. Lambs are usually given their first dose at weaning time, but earlier dosing may be necessary. If they are being grazed on heavily infested pasture the treatment should be repeated at monthly intervals throughout autumn and winter. Where serious disease exists because of the presence of round-worms an adequate initial dose should be given and repeated again after one week has elapsed and then again at fortnightly intervals until beneficial results are obvious. Subsequent to this, if the animals are still being maintained on the infested pasture, monthly dosing should be resorted to as already described. It will be understood that the frequency of treatment will vary with the likelihood of lambs becoming infested, that is, with the grazing conditions under which they are being kept.

It must not be thought that the routine treatment of all young sheep with phenothiazine is being advocated. Nevertheless there is good reason to believe that there are many cases of retarded development in this country which are due to undetected parasitic worm infestation. Where it is thought that lambs are not thriving as they should then administration of phenothiazine is a wise procedure.

Contamination at Lambing Time.

A point worth considering also is that the initial pasture contamination at lambing time is largely due to the fact that the ewes are carrying worms. The indication would seem to be that if such ewes were relatively worm-free then there would be less danger of lambs becoming affected to any extent. It seems reasonable to suppose that if the in-lamb ewes be dosed with phenothiazine prior to their being introduced to the pasture where they are to lamb, and provided that

pasture has been free of sheep for say six weeks or so, then the danger of infestation of lambs would be greatly reduced. That it would be entirely eliminated would be too much for which to hope.

It is becoming increasingly recognized that young cattle are subject to wasting disease and diarrhoea caused by round-worm infestation. *Haemonchus contortus* infestation is equally serious when it affects cattle and in all respects the same considerations apply to worm infestation of cattle as they do to sheep. The disease is subject to the same variation in severity and cattle respond equally well to dosing with phenothiazine.

Trouble in Horses.

Round-worms can cause serious trouble in horses. The most common, a large yellow-white worm, may be as thick as a lead pencil and up to one foot in length. It inhabits the small intestine and unless present in considerable numbers does not give rise to trouble. When the numbers are great, mild inflammation of the intestinal lining is caused and a considerable degree of indigestion may be present.

By far the most injurious to horses however are a number of small worms closely allied to those which affect sheep. They are taken up from the pasture when grazing and the larvae thus ingested can cause serious harm to the animal before they, the larvae, reach maturity. Such infestation is most common in young horses.

The larvae of certain species of these worms burrow into the wall of the horse's intestine and there they undergo further development until they emerge as mature adults. Other larvae utilize the walls of large arteries in the horse's abdomen for this purpose and cause weakening of the arterial wall with serious consequences in many cases. The actual route taken by these larvae to reach the walls of arteries in the roof of the abdomen is not properly understood but it is thought that they travel by the blood stream. After having developed into adult worms they leave the arteries and return to the intestine, but again the actual route followed is the subject of conjecture. Apart from the damage caused by larvae some species of the adult parasites themselves are active blood-suckers and damage the intestinal walls by this means and by biting.

Phenothiazine has proved to be of value for the treatment of round-worm infestation in horses but it will be realized that larvae which have penetrated into the wall of the bowel and those in arterial walls will remain unaffected. The amount of phenothiazine given to horses of different ages and sizes must be computed with some care so that it is certainly best to leave the matter of diagnosis and treatment to the skilled person.

Young pigs are subject to round-worm infestation of the intestine. The symptoms are unthriftiness and indigestion; and fits may develop in the seriously affected. Most pig-keepers are aware of the detrimental effects of these parasites and oil of chenopodium is commonly used in treatment.

Hoose or Husk.

Round-worm infestation of the respiratory system can be a very serious disease of sheep and cattle, particularly of the latter. Various names are given to the disease, the technical term being Parasitic Bronchitis, but farmers know it better as " Husk " or " Hoose."

The species of worm which attack cattle is different from that which is found in sheep and cross infestations do not occur—that is, the worm which attacks sheep is never found in cattle and that which causes Hoose in cattle cannot set up a similar condition in sheep. The disease is most common in damp low-lying pastures and the conditions which favour development of stomach and intestinal parasitism apply equally well to infestation of the respiratory passages. The worm parasites which cause Hoose are considerably larger than those which infest the stomach and intestines. These " threadworms," as they are called, are often about two inches in length and are of about the thickness of a thread. In severe cases of the disease they can be found in large numbers lying in groups in the bronchi and sometimes, when many parasites become entangled together, they cause complete blocking of bronchi. The effect of such infestation is to set up a severe bronchitis and in many occasions bacterial invasion of the affected parts occurs, resulting in an increase in severity of the disease so that pneumonia not uncommonly develops. Quite frequently severe worm infestation of the respiratory system and of the digestive system co-exist in the same animals.

Method of Development.

The method of development of these " lungworms " as they are often termed is similar to that of the stomach and intestinal parasites in that larvae develop on pasture and reach a stage when they are capable of persisting in the host animal. The female lungworm does not however lay eggs but gives birth to living larvae. These make their way up from the bronchi, or are coughed up to the region of the throat and are then swallowed; after passing through the digestive system they reach the pasture in the dung. It is possible that some may be coughed out directly on to the pasture. The infective larvae are picked up by the host-animals while grazing. They then reach the intestine where they penetrate the wall and enter a blood vessel. In the blood stream they are carried to the lungs where they penetrate into the tiny lung spaces. From there they reach the small bronchi where they become mature males or females.

Symptoms.

Animals affected with parasitic bronchitis

almost always have a cough, soft in nature; its severity and frequency varies with the seriousness of the condition: when parasites are many, coughing is very frequent, and paroxysms which leave the animal exhausted may occur. In such severe cases it would appear that the animal is temporarily unable to breathe until the obstructions caused by masses of worms are removed by violent coughing. Sometimes animals in which this occurs fall down because of partial asphyxiation. During fits of coughing masses of worms and a blood-streaked discharge may be expelled from the mouth. Such are the most severe cases and they almost always terminate fatally.

Most commonly the disease is much more chronic; coughing is much less frequent and less severe, but loss of condition is progressive, affected animals becoming unthrifty and listless and they have sunken eyes and staring coat. Chronic cases of the disease eventually die if measures of control are not adopted early enough.

Parasitic bronchitis principally affects young cattle and sheep, up to the age of one year, but adults are not completely resistant to the condition and serious outbreaks affecting mature dairy cows have been found. In general, the younger an animal is the more susceptible is it to the affects of lung worms.

Diagnosis.

When a severe outbreak of coughing occurs in a herd of young cattle or in a flock of lambs it is reasonable to suspect that " Hoose " is present if the animals are being kept in circumstances suitable for the parasites, that is, on damp pastures particularly when overcrowded. However it is possible for other chronic pneumonic conditions to give rise to similar symptoms so that absolute certainty of diagnosis cannot be obtained without further evidence. Sometimes worms which have been coughed up by affected animals will be observed, and in other cases laboratory examination of samples of dung will show the presence of larvae which have been passed out. Again examination of the carcase of a dead animal will reveal worms in large numbers in the lungs, and there are other symptoms which are commonly present. In very many cases however the circumstantial evidence in favour of the disease being Hoose is so strong that other additional means of diagnosis are not adopted.

Treatment.

It has been stated that infestation with lungworms is commonly associated with the presence of worms in the abomasum and intestine. These latter play their part in the production of illness of the host, so that one of the first measures of treatment is to dose all susceptible animals with phenothiazine or other reliable worm medicine. Such drugs have no effect on the lung worms because their action is restricted solely to the digestive system, but the removal of the worm burden from this situation gives affected animals a better opportunity to overcome the lung parasites. As soon as the disease is diagnosed all susceptible stock should be removed forthwith from the infested pasture and preferably placed in yards with adequate covering from inclement weather. And then if nutritious diet be given mildly affected animals will probably recover without further treatment.

Medicinal Treatment.

Where medicinal treatment is considered necessary it cannot be emphasized too strongly that no drugs given by mouth can reach worms which are present in the respiratory system. Many veterinary surgeons of experience and many farmers believe implicitly in the value of what are known as intratracheal injections. These consist of injecting into the windpipe or trachea drugs which it is thought will kill the worms. On more than one occasion this method of treatment has been attempted by owners themselves with disastrous results—they have not succeeded in inserting the hypodermic needle into the trachea and the injection has been made elsewhere in the neck. However, properly carried out, this method of treatment has many supporters.

Prevention.

Prevention of parasitic bronchitis is more difficult than prevention of worm infestation of the abomasum and intestine. Animals cannot be grazed on infested pasture and disease prevented by the regular administration of appropriate drugs. Nevertheless, and where pasture contamination with lungworm larvae is not too heavy, the maintenance of animals at a high level of nutrition combined with the elimination of worms in the digestive system will often enable them to resist the affects of lungworms; but where infestation is severe the only method of prevention is to keep susceptible animals off dangerous pasture. Since the lungworms of cattle and sheep are not interchangeable, pasture can be grazed alternately by young cattle and sheep and each will tend to clear the pasture of larvae for the other. It must be remembered however that conditions which are suitable for the development of cattle lungworms are also equally suitable for the development of those of sheep so that where one species of animal is likely to develop the disease so is the other. This means that if the condition develops among young cattle it cannot be assumed that the pasture will be safe for sheep for any length of time.

On the whole, cattle suffer more severely from parasitic bronchitis than do sheep and on some farms calves have to be reared in yards or boxes because, if put to pasture, they will contract Hoose. Channel Island cattle seem to be particularly susceptible and even adult animals appear to acquire little resistance to the effects of lungworm.

DISEASES CAUSED BY PARASITES (Concluded)

TAPEWORMS, LIVER FLUKE AND COCCIDIA.

Here some further worm parasites are dealt with. Tapeworms, flat worms, cause little harm to their hosts but Tapeworm Cysts can cause serious trouble. "Gid" or "Sturdy" in sheep is described. The amazing life-cycle of the Liver Fluke is noted and emphasis placed upon the serious diseases caused in sheep and cattle by this parasite. Coccidiosis, a malady well recognized in poultry, is described as it occurs in young cattle and lambs.

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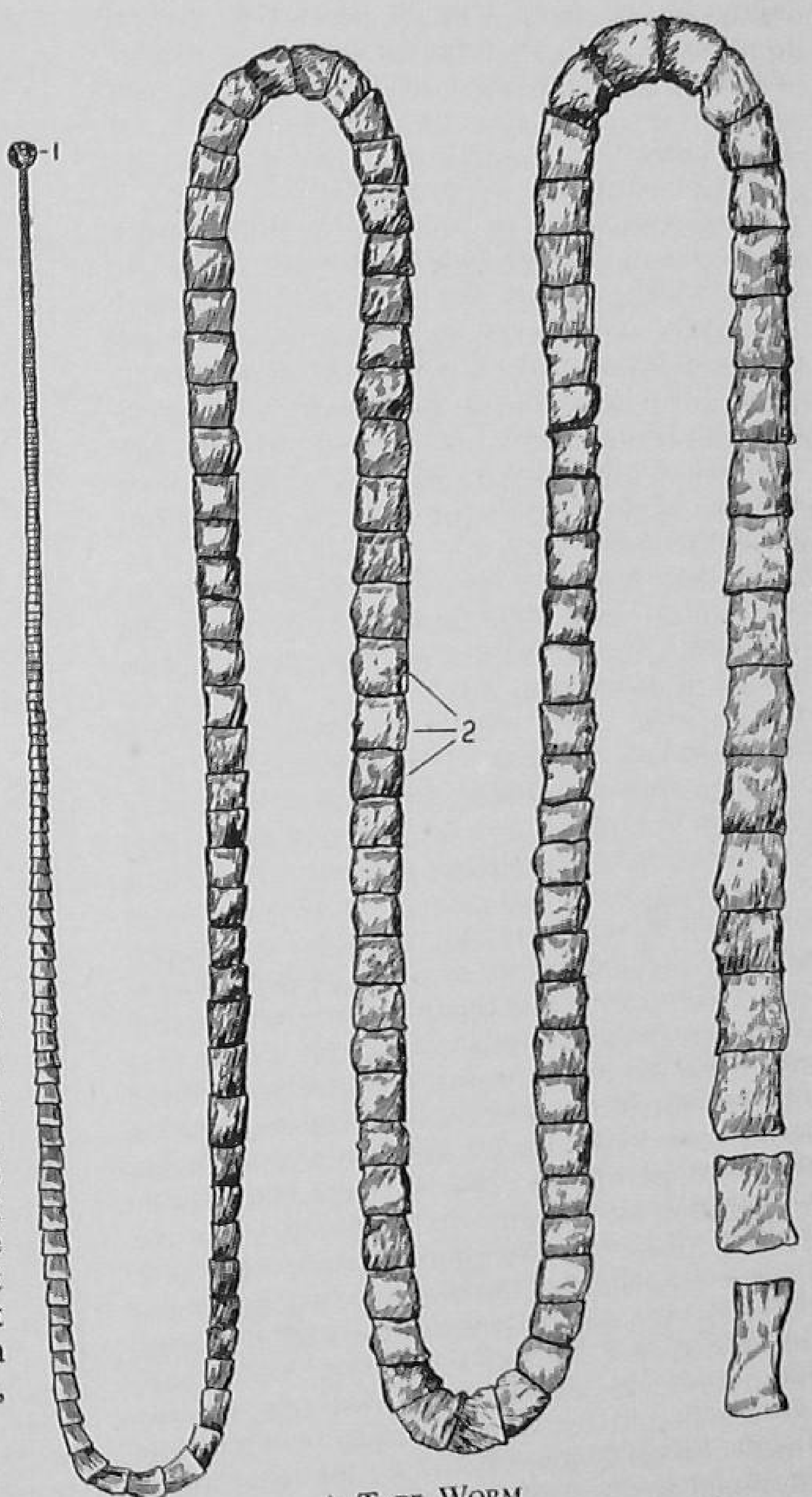
Tapeworms.

MOST domestic animals harbour different species of tapeworms from time to time. These worms differ from round-worms in shape being flat and ribbon-like and not cylindrical but resembling tape, hence the name. Most species can be seen readily with the naked eye and some attain a great length, being a number of yards from one extremity to the other. They live in the intestines of man and animals although animals are much more frequently affected than man.

Tapeworms are provided with a rounded head on which are a number of hooks or suckers or both. With them these parasites attach themselves to the internal lining of the intestine. No mouth is present because tapeworms do not obtain their nourishment by this means. The elongated body of a tapeworm extends backwards from the head and is divided into numerous segments. The segments grow from the head, new ones being produced continually. The segments at the tail end of the worm break away from the main body, pass through the remaining length of the intestine and out with the droppings. Except in the smallest species the segmentation of the tapeworm body can be seen with the unaided eye, giving it a banded appearance.

Both Sexes.

Tapeworms, like some other internal parasites, are remarkable in that both sexes are present in the same individual. Such beings are known as hermaphrodites. As segments are formed by the head of the tapeworm they become slowly displaced by the formation of other segments so that each segment in turn is gradually pushed along the train of segments, all however remaining attached end to end until the end of the worm is reached. It is here that segments break off and are freed. As each segment by the development and growth of new segments just behind the head gradually approaches the hinder end of the worm it gradually becomes mature and it develops both male and female reproductive organs. Spermatozoa are produced and these fertilize ova (i.e. eggs) formed by an ovary, the fertilized ova developing in a uterus or womb. When segments reach the end of the chain, that is the extremity of the worm, they contain many eggs and are little else than bags of eggs.



A TAPE WORM
1. Head. 2. Segments.

As has been indicated, when they break away from the main worm they pass out on to pasture, or elsewhere, in the dung.

In fresh dung, tapeworm segments can usually be seen as moist whitish bodies moving slightly, expanding and contracting. Very soon however they shrink to a smaller size, their covering becomes dry and quite hard and eventually ruptures, releasing the eggs.

No Digestive System.

Tapeworms obtain their nourishment by absorbing digested material through the walls of their bodies. This is in the form of those fluids present in the intestine which should serve to nourish the host. Thus, tapeworms have no digestive system. They are largely immovable and at most they expand and contract lengthwise. The head, which is anchored to the intestinal lining of the host, may be extremely difficult to dislodge and, as long as the head remains, segments will continue to grow.

Two Hosts.

A tapeworm has a complicated life-cycle. It requires two hosts in order to attain complete development. In its final stage, that is, as the worm which has just been described, the host is termed the definitive or final host, but before this stage can be reached a tapeworm must have spent a period of its existence in another host, called the intermediate host. In the intermediate host this type of parasite does not take on the form of a worm at all but is quite different in structure and appearance.

We have seen how the segments of tapeworms pass out of the body and how the eggs are liberated. Now, before an egg can develop further it must gain entry to the body of an intermediate host. As a general rule every animal has its own species of tapeworm but there are some tapeworms that can exist in more than one type of animal. Similarly certain tapeworms will utilize only one species as intermediate host but again in some cases any one of a number of hosts will serve. For example, a common tapeworm of the dog has the sheep as its intermediate host (although the preference for sheep is not absolute) whereas another tapeworm of the dog can make use of most animals and man as an intermediate host. For the most part tapeworms have shown some discrimination in their selection of intermediate hosts. They have not been chosen haphazardly. A parasite existing in the intermediate stage in a host must have a reasonable chance of finally gaining access to the body of a definitive host. Thus a sheep grazing on pasture can readily pick up tapeworm eggs which have come from the tapeworm of the dog already mentioned. In the sheep the egg will develop into the intermediate stage of a tapeworm and if this be consumed by a dog a tapeworm will grow within the dog's intestine. Under natural circumstances dogs would commonly kill and feed on sheep. Similarly rabbits and hares act as intermediate hosts for still another species of dog tapeworm and lice and fleas infesting dogs and cats harbour the intermediate forms of still another type common to dogs and cats. Again, a tapeworm of cats exists in the intermediate stage in rats and mice, animals which are often eaten by cats. Lambs may be heavily infested with tapeworms and in this case the intermediate hosts are mites which live on pastures and are accidentally consumed by lambs while grazing.

Bladder Worm.

The intermediate stage of a tapeworm is known as a Tapeworm Cyst or Bladder Worm. The egg of a tapeworm after having gained entry to the intermediate host develops into the head of a tapeworm which surrounds itself with a membrane filled with fluid. The head of the future tapeworm is attached to the inner surface of the membrane and is suspended in the fluid. Some such bladder worms may attain the size of a tennis ball or may be even larger and some are quite small, depending on the species. In some species more than one head is present in the bladder. Bladder worms show a preference for certain parts or organs of the intermediate host. Thus the bladder worm which develops in sheep as a result of their consuming an egg of the tapeworm of the dog almost always selects the brain surface for its site of development with serious consequences for the sheep, as will be seen later. Again the tapeworm of the cat which has rats and mice as intermediate hosts forms its intermediate stage in the livers of these rodents. Other situations inhabited by bladder worms in different animals are peritoneum, lungs, muscles and various other organs of the body.

Loss of Condition.

For the most part, tapeworms cause little harm to their hosts, but if they are present in large numbers the affected animals may suffer some loss of condition. In such cases the tapeworms deprive the host of the necessary amount of nourishment by absorbing a considerable part of that coming from the food. Tapeworms are vary common in dogs and cats but they rarely cause trouble. Their presence is extremely objectionable in these animals when they are kept as pets; segments of tapeworm may come from them when indoors.

Pigs are rarely if ever affected with tapeworms. On occasion they are to be found in horses and cattle, while sheep commonly harbour a number of such worms. When infestation is heavy in lambs some loss of condition may be evident and sometimes masses of tapeworms may cause death by completely blocking the intestine.

Hooks.

Some tapeworms are very difficult to eradicate even when the hosts are given appropriate medicines. Others are comparatively simple to remove. As a general rule if a tapeworm possesses hooks by which its head is attached to the intestinal lining it will have a very firm attachment which is difficult to loosen; on the other hand those species possessing suckers only can be detached and expelled from the intestine much more readily.

Bladder Worms.

Bladder worms can have very serious effects on their hosts depending on their situation and the size to which they grow. The species which develops on the brain of a sheep has already been mentioned. There it will grow to the size of a half-crown piece or even larger and by reason of the pressure which it exerts on the brain can set up serious symptoms in the sheep and may eventually cause its death. The disease which results from the presence of a bladder worm in a sheep's brain is well recognized and is called "Gid" or "Sturdy."

Gid.

Sheep affected with Gid behave in a most peculiar manner. The functional upset in the brain results in their losing voluntary control of muscles and erratic and aimless movements are exhibited. Affected sheep leave the rest of the flock and appear unconscious of the presence of other sheep. Some stand with their heads pressed against a fence or post and seem unable to leave this situation; others, when moved, are unable to walk in a straight line and turn in circles with the head carried downwards or to one side. At other times affected sheep are unable to rise whilst other stumble forwards when moved. In fact almost any form of erratic and unusual locomotion can be seen, and on occasion sheep have been known to turn backward somersaults.

An attack of Gid invariable ends in death. If an affected animal is of sufficient value to warrant the operation the tapeworm cyst (bladder worm) can often be removed surgically, after which recovery quickly ensues.

A Serious Disease.

A serious disease caused by the presence of tapeworm cysts can affect man and almost all animals. The parent tapeworm inhabits the intestines of dogs and cats; it is extremely small, being little more than a quarter of an inch in length. The eggs which are released can form bladder worms as large as a cocoanut and they differ in size between that and the size of a pea. Their principal seat of development is the liver and, less frequently, muscle. Each cyst which is formed may contain a number of other cysts each of which contains several potential tapeworm heads. Such cysts, if ruptured, can give rise to a number of further cysts.

When members of such bladder worms are present in the liver or elsewhere serious trouble or even death may follow. An affected liver becomes extremely enlarged and may press on other vital organs apart from the derangement of the function of the liver itself. The condition is found not uncommonly in cattle and sheep but infestation of man is of less frequent occurrence. Nevertheless, the danger always exists that fondling of cats and dogs may lead to infestation of humans.

(ii)

Liver Fluke.

A parasite of great economic importance which causes serious disease in sheep and cattle is the Liver Fluke. It is found occasionally in other animals but it rarely if ever sets up symptoms of disease in them. Adult flukes are leaf-shaped, of a brownish transparent colour and are about three quarters of an inch long. They inhabit the liver where they can cause serious damage. Flukes are hermaphrodite, each individual producing eggs.

Habits.

Before considering the life history of liver flukes and in order to understand better their habits it will be necessary to give a brief description of the liver, the home of the adult fluke. The liver, present in all animals and man, is a solid organ which lies against the hinder surface of the diaphragm. It is composed of a dense mass of cells supported by a frame work of tougher tissue and a close network of blood vessels is present throughout. Liver cells, apart from other functions produce bile, a greenish coloured fluid which is collected by tiny channels which unite to form larger channels and so on until one large channel leaves the liver and carries all the bile which is produced. In most animals (the horse being a notable exception) the liver is provided with a small bladder at the point where the main bile channel leaves the liver. This is the gall bladder and it serves as a reservoir to store excess bile until it can be carried away. The channels which carry bile are called bile ducts and the main bile duct transports bile to the intestine into which it opens.

Amazing Life Cycle.

The amazing life-cycle of the liver fluke merits attention in some detail. Apart from its being necessary to know the facts in order to appreciate the reason for the application of certain measures of control, the life-cycle of the liver fluke is truly one of the wonders of nature and as such it deserves special attention. Also, in order to explain the various forms which the parasite assumes it will be necessary to use the technical name that is applied to each.

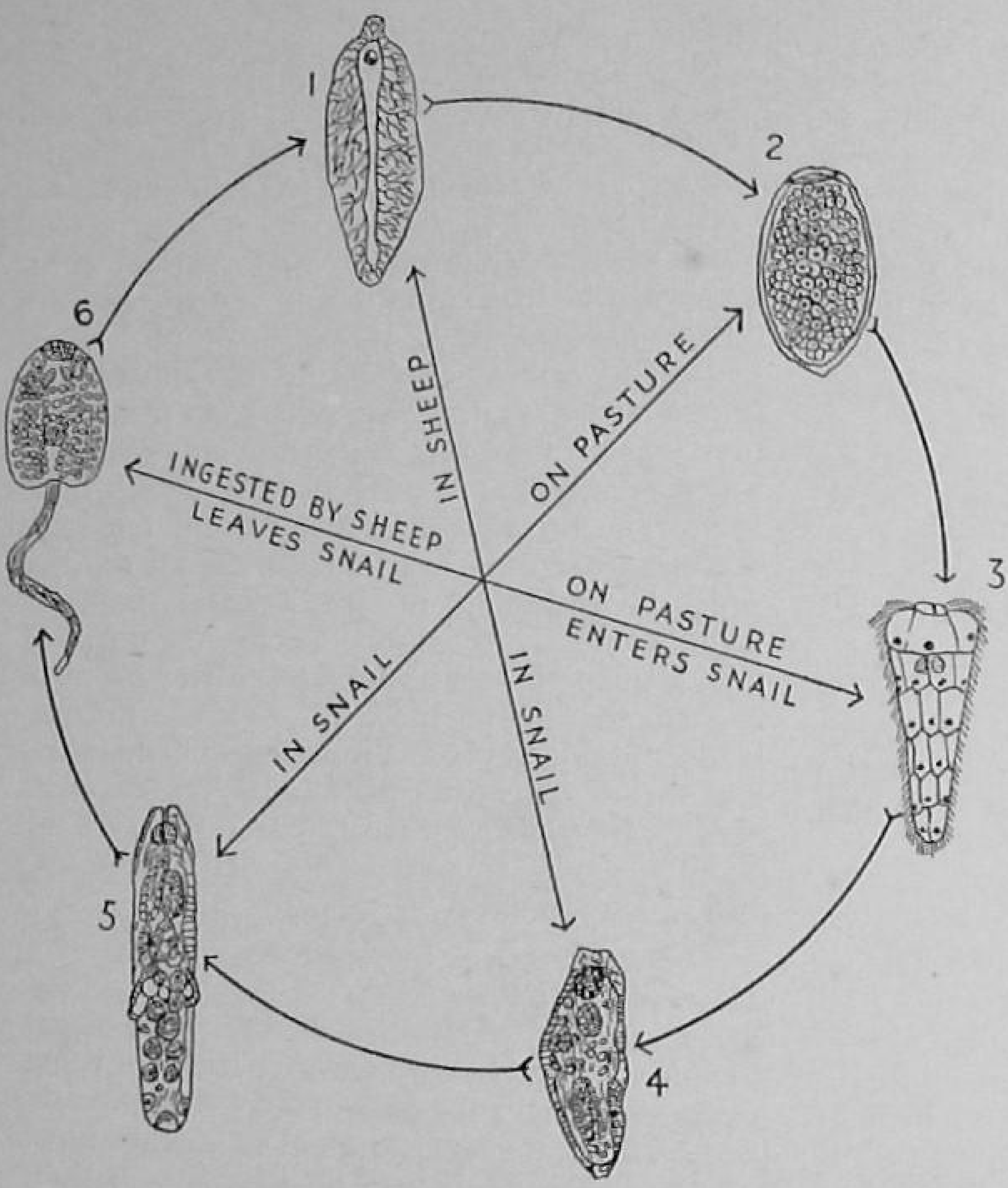
Adult flukes inhabit the larger bile ducts of the liver. There they lay eggs which are carried off with the bile, through the main bile duct and so to the intestine. In the intestine eggs pass along with the intestinal contents and eventually reach the pasture in dung. Eggs hatch in nine days time under optimum circumstances but in conditions less favourable they may remain viable for five months or more. Therefore fluke eggs may hatch at any time between these two extremes. The embryo or little grub which emerges is called a *Miracidium*. It can move about on wet land but it perishes within a short time if it does not

find the necessary intermediate host—a small fresh water snail called *Limnaea truncatula.*

Intermediate Host.

This snail is about one half-inch in length and one quarter-inch in width. It has a spiral conical shell of a greyish colour and it is found in almost every country in the world. In this country at least it is the only intermediate host which is suitable for the liver fluke.

Having found a snail the *Miracidium* bores its way into the body of the snail and changes to another form called a *Sporocyst*. The *sporocyst* is capable of dividing into a number of bodies each of which becomes a *sporocyst*. Also each *sporocyst* produces within itself a number of further generations (six to eight in number) called *Rediae*. These *rediae* are set free from the bodies of the *sporocysts*, which then die, and each *redia* migrates to the snail's liver where at last a generation is produced which is called a *Cercaria*. *Cercariae*, escape from the snail after a time and swim about in water. For this purpose they are provided with tails. Soon, however, each *cercaria* attaches itself to a blade of grass or some other form of herbage, loses its tail and surrounds itself with a resistant covering. In this state *cercariae* can exist on pasture for a year or more. Development within the snail takes six to seven weeks.



LIFE CYCLE OF LIVER FLUKE

1. Adult Fluke.
2. Egg of Fluke.
3. Miracidium.
4. Sporocyst.
5. Redia.
6. Cercaria.

Cattle and sheep swallow numbers of *cercariae* while grazing and on reaching the intestine the *cercariae* bore through the intestinal wall and reach the abdominal cavity where they live for a few days. After this they penetrate into the substance of the host animal's liver where they wander about for a period of five to six weeks. During this time *cercariae* have been developing gradually into flukes and the final part of development takes place when they settle in the bile ducts of the liver. Flukes feed by sucking blood and apart from this method of damaging the host they cause extreme irritation in the liver and damage to its substance while moving about within that organ prior to settling in the bile ducts. When an animal has become infested with *cercariae* the resulting flukes will have reached maturity and will have commenced to lay eggs in from eleven to thirteen weeks. Complete development, from egg to adult fluke, takes about three months.

Liver Rot.

Liver Fluke Disease or Liver Rot is a very serious condition in sheep and cattle. Two forms of the malady are recognized, one acute, the other chronic. Acute disease is rarely found in cattle, the chronic form being by far the more common.

Sheep affected with acute liver fluke disease may die within a few days. Affected animals are obviously ill although perhaps in excellent condition. In these cases death is due to extreme liver damage caused by large numbers of immature flukes moving about within the liver substance.

Chronic Liver Rot is more common in sheep than the acute form of the disease. The symptoms are progressive weakness, anaemia, loss of condition; swellings may develop under the jaws of affected animals and the lower part of the abdomen may become swollen with an accumulation of fluid. Extreme emaciation may result and many affected animals may die.

In cattle the symptoms are similar to those of chronic fluke disease of sheep except that they usually develop more slowly.

Damp Pasture.

The incidence of liver disease is almost wholly restricted to animals which are or have

been grazing on marshy or damp pasture. Only in such situations are conditions found that are suitable for the existence of the snail which acts as intermediate host. Also the prevalence of the disease in any one season is related directly to the number of snails present. Again fluke disease assumes most serious proportions at a time of the year which follows the period when the particular snails have reached their peak of multiplication. The snails first appear in March or April; when adult they lay eggs and this results in a new generation of snails arising some three or four months later. A third generation may appear about October and if conditions have been suitable many snails may be present in the second generation and enormous numbers in the third.

It has been found that flukes derived from the first generation of snails do not appear until early July. The numbers at this time however are often not many. The second generation of snails however may harbour many immature flukes which appear in late August and September, and it is at this time that outbreaks of acute liver fluke disease may appear in sheep. Chronic disease does not usually become evident until some time later and it can occur at almost any time throughout the winter.

Treatment.

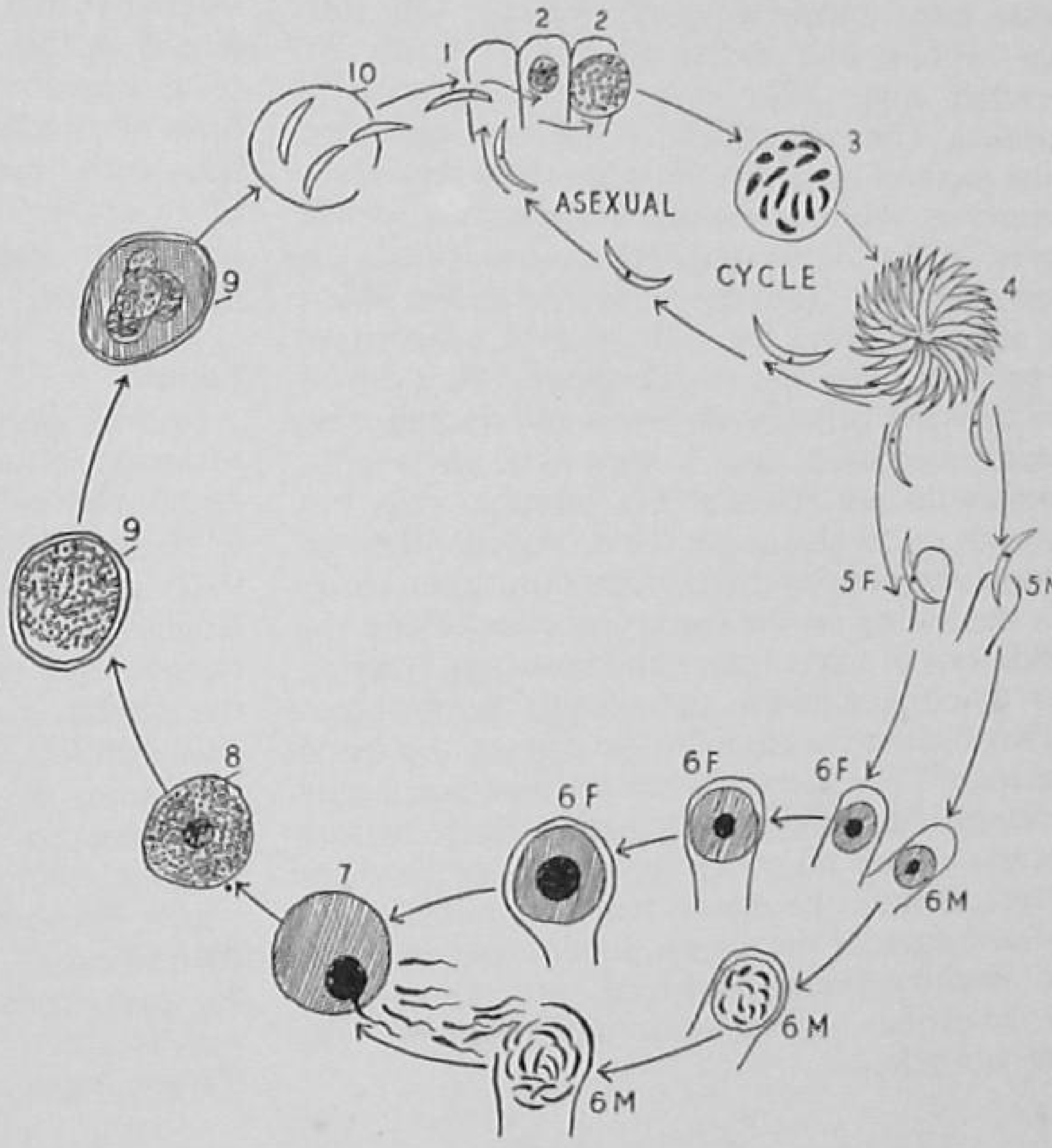
Medicinal treatment of acute liver fluke disease is not possible but the remedy for the chronic condition is well known. Carbon tetrachloride in capsules, each containing one cubic centimetre of the drug is effective in sheep if they are dosed before the disease is too far advanced. This drug is not suitable for cattle.

It is hardly necessary to state that a reduction in the numbers of the intermediate host snails will result in a decrease in the incidence of liver fluke disease. Therefore any measures directed towards this end will be well worth while. The principal operation is the maintenance of adequate pasture drainage. Ditches and open drains should be cleaned regularly and kept free of herbage so that animals will not graze in their close vicinity. It has been stated however that ditches should not be cleaned out during the late summer or autumn or snails will then be deposited on the pasture and *cercariae* will be liberated. Copper sulphate (bluestone) can be used in an attempt to kill the snails. It is applied to likely breeding places at the rate of 20 lb. per acre, one part of copper sulphate being mixed with four parts of sand, the mixture being broadcast.

(iii)

Coccidiosis.

The disease called *Coccidiosis* is familar to most poultry-keepers. It affects principally half-grown chicks and heavy losses may be incurred in severe outbreaks. It may not be generally known however that Coccidiosis attacks young cattle and the writer has experienced quite severe outbreaks in lambs. Young rabbits are frequently affected with the condition and it is probably the most serious menace to the rabbit breeding industry.



LIFE CYCLE OF COCCIDIUM

1. Parasite entering cell. 2. Parasite growing and rupturing cell. 3. Free in intestine. 4. Subdividing and repeating asexual cycle or commencing sexual cycle. 5M. Male parasite and 5F female parasite. 6M, 6F. Male and female parasites developing in cells. 7. Female parasite being fertilized by male. 8. Fertilized female. 9. Developing oöcyst. 10. Parasites leaving oöcyst and entering cell to begin asexual cycle.

There is some diversity of opinion as to whether Coccidiosis actually causes disease in cattle in Great Britain. It undoubtedly does so in certain other countries but many assert that so-called outbreaks in this country have been cases of mistaken diagnosis. Evidence of the presence of the parasites can be found in many animals in normal health a fact which serves to make certain diagnosis rather difficult. The author subscribes

to the opinion that Coccidiosis can and does occur in this country to the extent of producing disease in cattle.

Protozoon Parasites.

Coccidiosis is caused by a protozoon parasite called *Coccidium*. Different species affect different animals and birds so that there is no danger of cattle or rabbits becoming infested by parasites derived from poultry. At one stage of the life-cycle the parasites enter the cells of the lining of the intestine. There they increase in size and divide into numerous small bodies. The cells then rupture and the small bodies which are liberated enter other cells and the process is repeated. The cycle which has just been described is the method by which these parasites reproduce themselves without assuming male and female forms. When the asexual cycle (as it is called) has been repeated a number of times the bodies which are liberated from the cells become adapted so as to form male and female types. Male forms join together with female forms and the resulting organism in each case is known as an Oöcyst. Oöcysts do not re-enter the intestinal cells but pass out on to pasture in the droppings. On the pasture the oöcysts mature, the time taken to do this depending on the species of parasite and the conditions of temperature and moisture. During this developing phase the oöcysts form spores within themselves (four in the case of the cattle species of *Coccidium*). When the spores are fully developed the oöcyst is mature. Such mature oöcysts, when taken up by cattle in food or water, release the spores in the animals' intestines, each of the spores divides into two and the resulting bodies penetrate into the cells of the intestinal lining thus recommencing the asexual cycle.

Young Cattle.

As has been said young cattle are most susceptible to Coccidiosis. The parasites in the intestine must be many before disease is produced. In such a case severe damage is caused to the intestinal lining; diarrhoea is set up and blood is often present in the discharge. Severe straining is frequently seen after evacuation of the bowel. An affected animal becomes weak and anaemic and death may follow.

From consideration of the life-cycle of the parasite it will be seen that since a *Coccidium* remains only for a limited period within the host the individual parasites do not accumulate to any extent in the animal. This means that either a fairly massive infestation must take place at one time or smaller numbers must be taken up very frequently before disease can arise. Removal of an animal from infested pasture should result in a fairly speedy elimination of all the parasites from its body.

Lambs.

Lambs become infested in a manner similar to cattle. Numbers of deaths can occur in a flock and it may be that the condition is more common in these animals than is generally supposed and that it remains undiagnosed. It cannot be detected with certainty in any animal except by microscopic examination of samples of dung for the detection of oöcysts or demonstration of the parasites in the intestinal lining after death. The symptoms of the disease however may lead one to suspect its presence.

Quite recently a new drug has been discovered which promises to be an effective remedy for Coccidiosis. Its value in the disease in chicks has been proved, but its use in animals has not yet assumed sufficient proportions to warrant the assumption that it will be equally useful.

SECTION II

GOOD MILK FARMING

by

PROF. H. G. ROBINSON M.Sc.
Director of the University of Nottingham
School of Agriculture

Illustrated by
BARBARA DOMINY

INTRODUCTORY NOTE

BECAUSE it is devoted to food-production, farming must always be regarded as the most important of our industries since it provides man with the means of living; and milk-production is the most important of all British farming activities.

Economic Possibilities.

Our approach to the subject of milk-production should be based on its economic possibilities. It was a criticism levelled at the scientist of old that he was concerned with theories that were quite independent of economic relationships. Many practical farmers also have been known to pursue an ideal without due concern for the financial outcome of their practice. Wisdom has been evolved from errors, however, and experience shows that what we have to learn must be related to a better understanding of how to earn a living.

Equally necessary is the importance of keeping up with the times, of having a mind sufficiently flexible to cope with the demands of progress. It is foolish to assume that the last word has been said about anything, but it is equally unwise to go to the other extreme and think that only the new discoveries embrace the most worth-while methods. Agriculture is an old industry—the oldest known to civilized man—and it would be idle to pretend that our forefathers did not number wise men among them.

We may follow agriculture as an occupation because we like it. It is important that our occupation should give enjoyment, but with most of us the main concern about our occupation is that it should provide the best possible living according to our capacities and opportunities. In so far as dairy farming is concerned, evidence abounds to prove that success depends greatly on the individual, the training and outlook, as well as upon the capacity for cultivating efficiency and translating it into the normal practice and conduct of every-day life.

It is assumed sometimes that luck plays a big part in farming successes. Dairy-farming requires all the luck that is going, but fortunately there are few problems that cannot be mastered and if the student is resolute in the pursuit of knowledge from those who know, then luck is relegated to its proper place and dairy farming becomes something that is living and full of interest to those who embark upon it for a livelihood.

Good Milk.

Good milk has been "priority food number one" ever since 1939. Not only is it a complete food in itself, but its richness in vitamins and most of the minerals and desirable elements contribute to the maintenance of a high standard of health. Experiments made in the feeding of milk in adequate amounts to children have proved its capacity for increasing not only height and physique but also resistance to disease and dental decay. If the dairy farmer and his workers think deeply of their responsibilities to the rest of the community, they have the satisfaction of knowing that they produce something that is more directly concerned with the future of our race than any other food. Medical opinion shares the view that milk-consumption should be much increased beyond the 0·4 pints per head per day of the pre-war era. With an expanding market to be developed, the 150,000 milk-producers in England and Wales have considerable responsibilities. When there is a worth-while purpose to be served in life, this of itself is some recompense for the hard labour which belongs to an occupation that carries on for seven days of each week, all the year round.

Good dairy-farming practice results from the pooling of knowledge gained in the hard field of practice and from the fruits of research. The theory is to the practising milk-producer what the navigation of an aeroplane is to the pilot. It is the means of reaching the target with greater certainty as well as providing a more certain living.

My thanks are due to Mrs. Barbara Dominy for the original drawings that illustrate the text.

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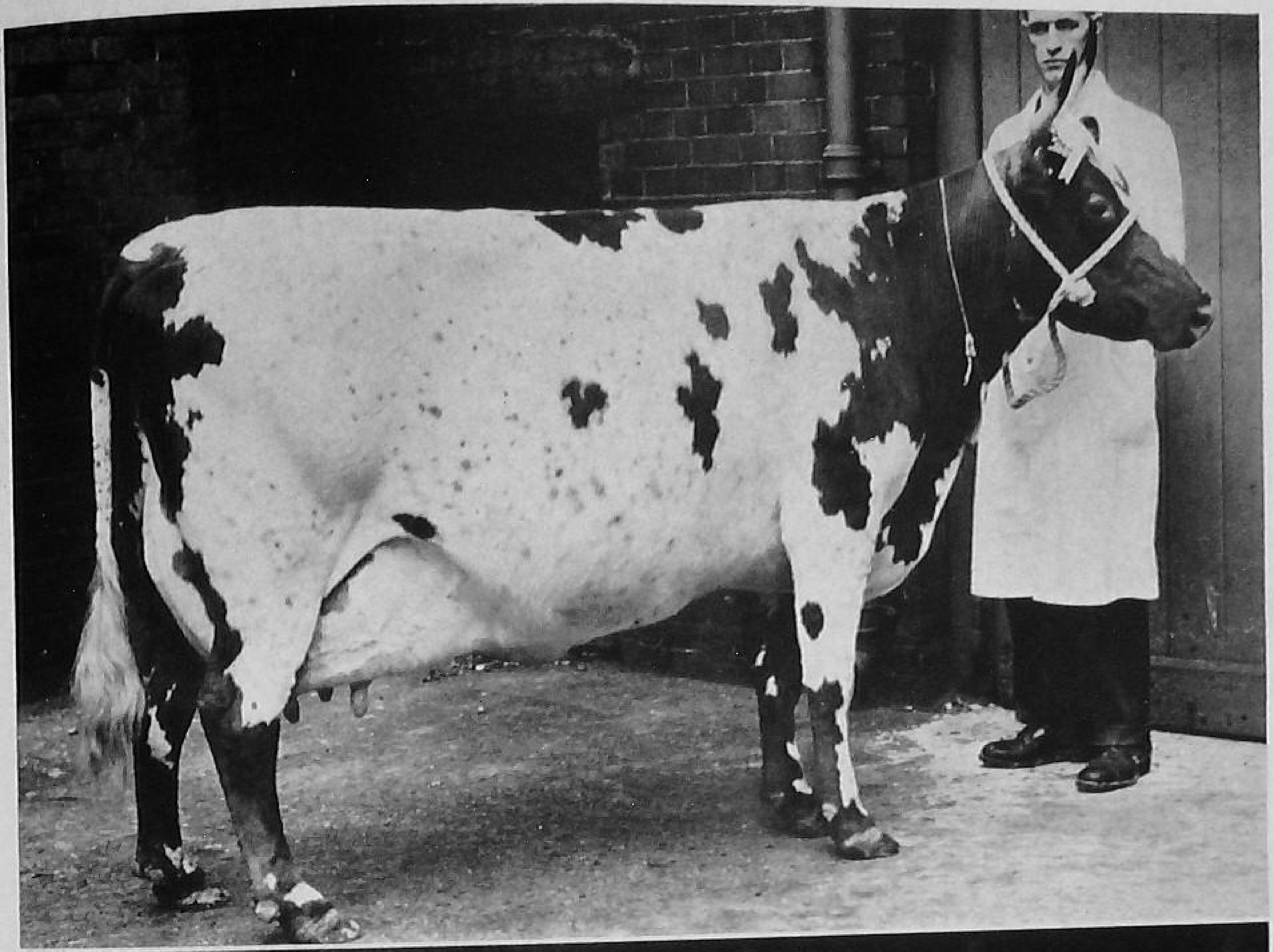


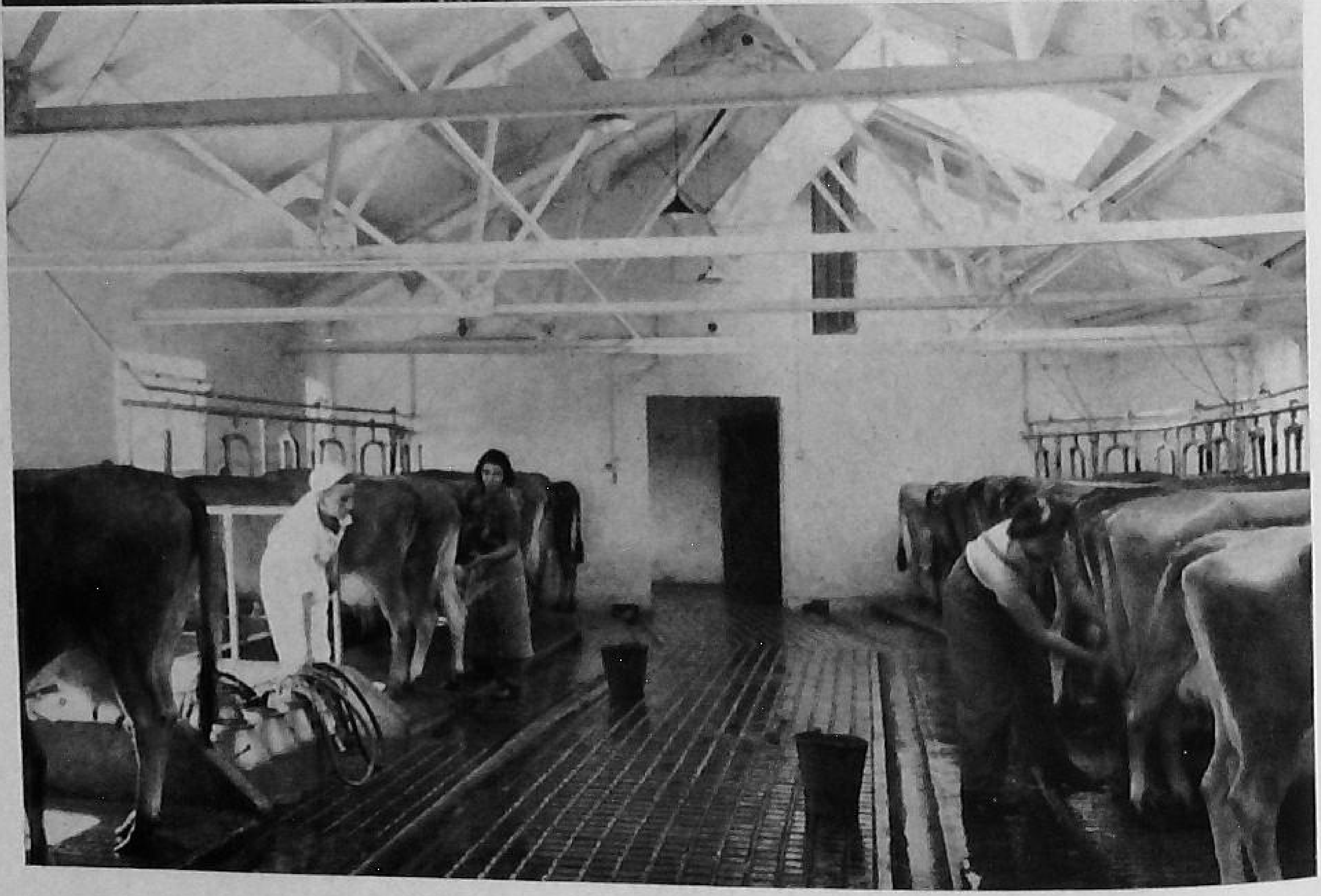
BRITISH FARM STOCK

Above : AYRSHIRE COW

Farmer & Stockbreeder Photograph

Below : YOUNG FARMERS' CLUBS ARE AN IMPORTANT FEATURE OF COUNTRY LIFE TODAY

Kent Messenger Photograph

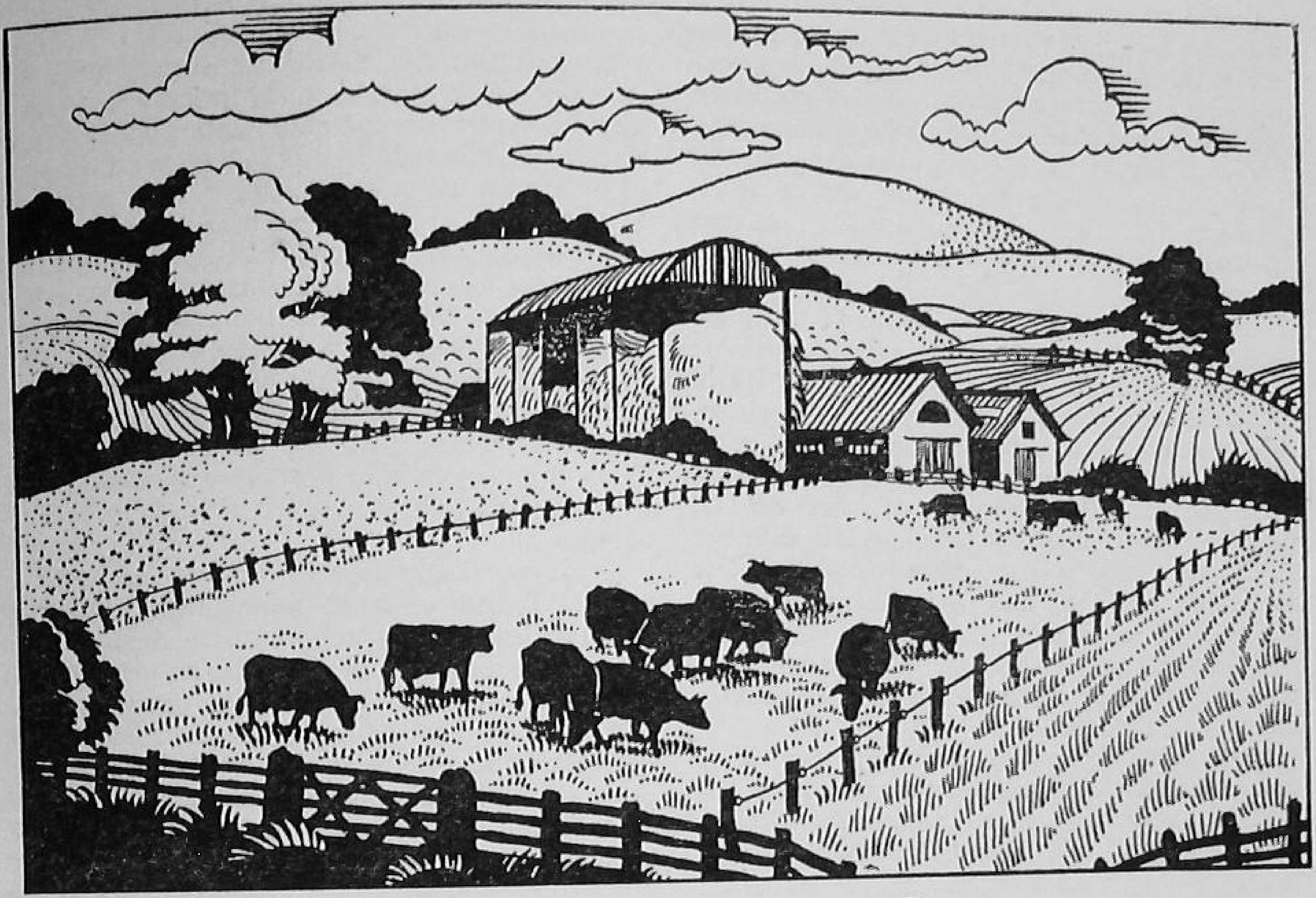


MODERN FARMING

Above : YOUNG STOCK IN THE YARD

Below : THE MILKING PARLOUR

Photos: Courtesy Messrs. Chivers & Sons, Ltd., Histon



DAIRY FARM SCENE—COWS GRAZING ON PASTURE.

THE BUSINESS OF MILK-PRODUCTION

In this first section is explained why Dairy Farming is attractive as a business. The functions of The Milk Marketing Board are described and an account of the use of milk in this country is given.

WHY DAIRY FARMING IS ATTRACTIVE.

Economic Efficiency.

IN all countries following intensive forms of agriculture, milk-production is important. On economic grounds, the dairy cow is the most efficient and economical converter of farm foods into human food. Pigs and poultry are the closest rivals, but it should be observed that there is a significant difference between these and the dairy cow. While cows consume large quantities of bulky home-grown foods they depend on concentrates for less than one-fifth of their total ration, whereas pigs and poultry require practically the whole of their diet in the form of grain and meals. On grounds of economic efficiency the milk-producing cow is always likely to give a better return than beef or mutton producing animals.

The second important attraction is the existence of a definite market for milk at all times of the year, with freedom from foreign competition and the provision of a regular income month by month for the producer. The security of the market is aided further by a system of price fixation which has regard to the actual costs of production, while the regularity with which income from milk sales is received permits the dairy farmer to make better use of his capital by a quicker turnover than is possible with beef or with arable crops.

The third advantage is that the dairy cow produces large quantities of manure and thus the milk-producing farm under proper conditions of management can be maintained in a satisfactory state of fertility.

There are various detractions which have to be recognized. The most important of these relates to labour difficulties. Milk production continues all the year round and every day of the week. Good labour with high intelligence is necessary for the best results and an adequate reserve of labour is necessary in these days to ease the work at the week-ends. The mechanization of the milking process and ranching methods of keeping cows have eased labour difficulties in many cases.

The number of registered milk-producers in England and Wales is 150,000.

THE MILK MARKETING BOARD.

Much of the stability in milk-production belongs to the fact that under the Agricultural Marketing Act of 1933, milk producers voted for the creation of a Milk Marketing Scheme. The Milk Marketing Board is the executive

authority responsible for the scheme and consists of twelve members elected by the eleven regions into which the country is divided, three special members elected by a national vote of producers and two independent members who are co-opted. For each region there is an elected committee consisting of county representatives of milk-producers. The functions of the regional committees are to advise the Board on matters of importance.

The powers vested in the Board concern the control and regulation of the sale of milk by producers and the determination of the price and conditions of sale, whether sold in the wholesale or retail markets by producers. Failure to observe the regulations renders defaulting producers liable to the imposition of penalties. In practice milk-producers make contracts with the Board each year and the Board is responsible for finding a market, and payments for the milk supplied by producers is made by the Milk Marketing Board each month. There is no direct payment of the producer by the seller of milk in the wholesale market.

In the case of the producer-retailer, there is an obligation on the producer's part to inform the Board monthly of his sales, and a further obligation to pay to the Board any levy deemed necessary for the maintenance of stabilized markets.

The farmhouse cheesemakers similarly make a return of the amount of milk manufactured into cheese, and the Board makes grants with the object of ensuring that the financial returns are comparable with those of producers selling milk on the wholesale market.

In 1943 the Milk Marketing Board assumed the responsibility for official milk-recording and butter-fat testing in England and Wales and in 1944 it was empowered to operate centres for artificial insemination.

The control exercised by the Board over the use of milk empowers them to allocate supplies to ensure that the best returns are received by producers. Milk can be diverted by the Board to whatever purpose is deemed desirable. This is closely related to the influence of manufactured imports on the home market. Thus during early summer, production of milk tends to be greater than the needs of the consuming population for fresh milk. In such cases provision is made for the manufacture of the surplus into butter, cheese, condensed milk, milk powder, tinned and bottled cream, and fresh cream. As home-produced manufactured milk-products have to be sold in competition with imported products, it has been necessary for the Board to supply milk for manufacturing purposes at prices that allow manufacturers to compete with imported products. This in turn has its influence on the price of milk returned to the producer. The price paid by the manufacturer for his milk depends on the product to be manufactured. The greatest assistance has been necessary for the butter producer and the least for the producer of fresh cream. In the first five years of the Milk Marketing Board's operations, the cost of production of milk on the farm averaged about 9½d. per gallon. In the same period, after deducting cost of transport, manufacturing milk only realized half of what it cost dairy farmers to produce it.

The control exercised in this way has made it possible to utilize surplus milk for manufacturing without leading to undercutting in the retail market for liquid milk, and the maintenance of adequate prices to compensate dairy farmers. The pre-war rates of levies for the loss through the sale of surplus milk for manufacturing and other services, including the administration of the scheme and the bonus paid to accredited milk producers, averaged about 2¾d. per gallon for producer-wholesalers and 1½d. per gallon for producer-retailers.

The Utilization of Milk.

The Consumption of Milk.

The market for milk is immense and it continues to expand. In 1938, the sales in England and Wales on the liquid market for human consumption amounted to 752 million gallons, representing 70·8 per cent of the total sales. 287 million gallons went into the manufacture of dairy produce and 24 million gallons were utilized for manufacture into cheese on the farm. Thus all but just over 2 per cent of the total marketable production was sold off the farms. The consumption of liquid milk in the year 1937–38 averaged 0·42 pints daily per head of the population. The Milk Marketing Board by advertising campaigns has popularized the consumption of milk. In other directions schemes have been developed for the supply of milk to school children, nursing mothers, and industrial workers, while milk bars have also become a a feature in most large towns and cities.

SYSTEMS OF MILK-PRODUCTION

Here are set out in some detail the schemes and plans of business followed by (a) The Retailer-Producer. (b) The Wholesale Producer. (c) The Farmhouse Cheesemaker and in (d) Cream Production and Butter-making.

Systems of Production.

SINCE the introduction of compulsory milk-marketing through the Milk Marketing Board in 1933 there has been a considerable levelling up in the systems of milk-production and a greater concentration on sales of liquid milk as distinct from farmhouse conversion into dairy products like cheese and butter. The rationalization which has been taking place gradually in the organization of the distributive and large-scale manufacturing sides has also tended to widen the interest in milk-production for sale on the liquid market and, in so far as large consuming centres are concerned, this has limited the activities of the producer-retailer. It is important to recognize that the existence of a definite market has given producers an advantage denied hitherto to almost every other branch of intensive food production. The production of milk is by no means constant owing to seasonal fluctuations, due in part to the natural tendency for the greater number of cows to calve down in spring and the flush in production resulting from the availability of an abundance of grass in spring. The problem of surplus production in the summer has been solved to some extent by the organization of manufacturing plants, either by commercial firms, or the Milk Marketing Board. The commercial market is a vast one and includes the manufacture of condensed milk, milk powders, cheese, butter, ice-cream, as well as the milk utilized for proprietary foods, chocolates and other products.

THE PRODUCER-RETAILER.

" Milk-and-Feed " Dairy Farming.

This system is followed where the producer farms near a consuming centre, but, in view of high rental charges, necessitates concentration on an intensive form of production. The practice normally followed is what is known as " milk-and-feed " dairy farming. This means keeping good yielding cows that will also fatten off satisfactorily so as to be marketed when dry. Dual-purpose type cows, calving their third or fourth calf are usually bought and heavy feeding with concentrates is practised, since home-grown foods are limited, though brewery offals are often used extensively. Though the returns from this system enable the producer to earn both the producer's and the retailer's profits, the costs are correspondingly heavy. Labour is more difficult to retain in this form of farming because industrial labour works shorter hours. The business is also being increasingly complicated by the growing competition from large-scale dairying distributive companies and co-operative societies with modern facilities for handling, heat-treating and delivering milk. A uniform quantity of milk has to be produced, but this is made possible by replacements of drying-off cows. A heavy depreciation between the buying-in price and the selling-out price has to be faced, which in normal times may amount to £8 or £10 or even more per cow. In country districts producer-retailers often maintain a breeding herd, but taken as a whole producer-retailer herds are small in size, averaging 13 cows per herd for the country.

THE WHOLESALE PRODUCER.

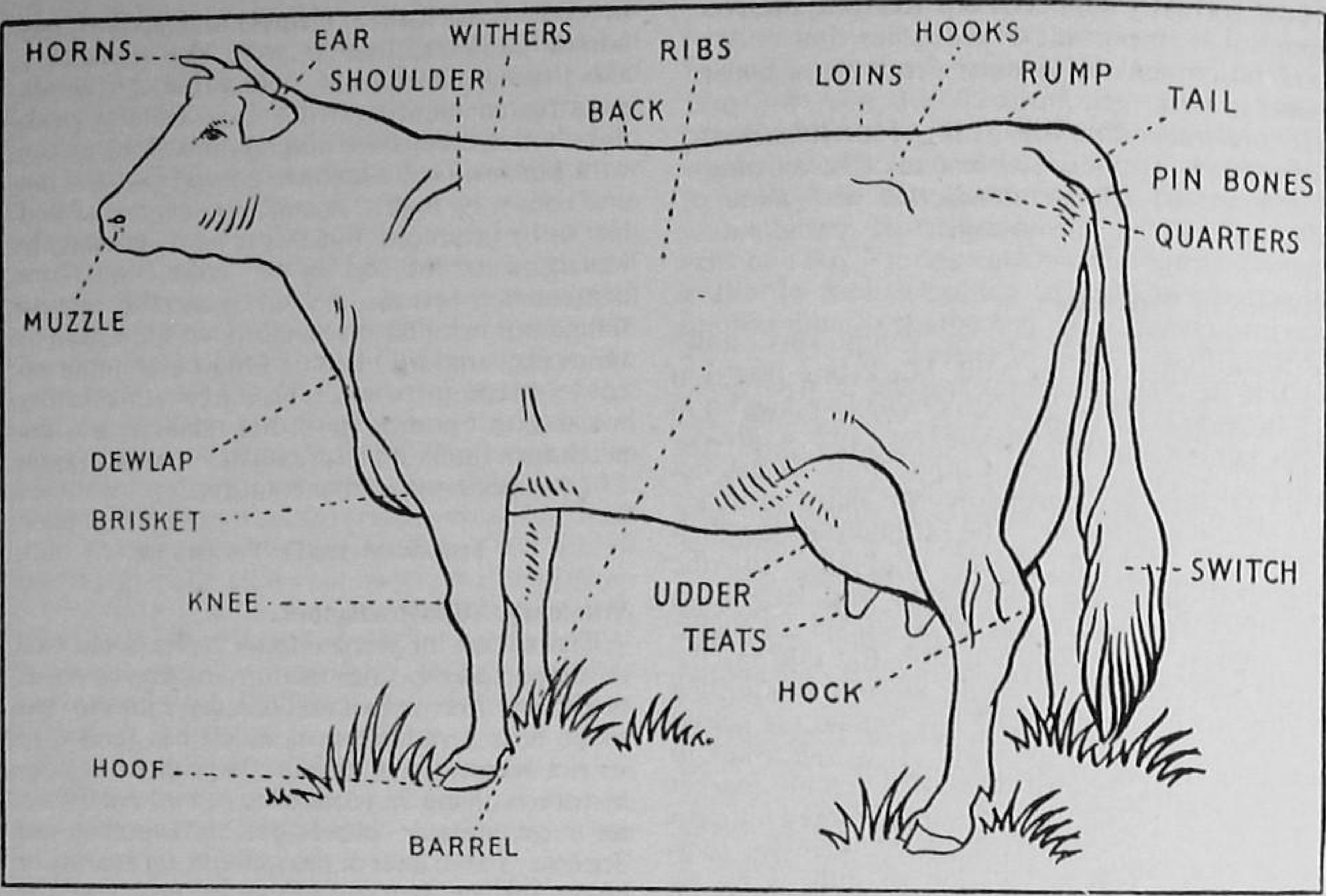
Wholesale Milk-Production.

The system of wholesale milk-production has developed greatly since the introduction of motor transport. Formerly it was necessary for the farm to be near a railway station, with a good train service at convenient times. It has also developed in very outlying districts where dairy companies have established collecting and manufacturing depots. In the days of the agricultural depression many former beef-producers changed over to milk-production, overcoming the limitations in respect of buildings and labour by the use of Hosier milking bails and the employment of milking machines.

There is no uniformity regarding the exact system followed, as many country producers have followed a milk-and-feed system. The ideal however is to keep a regular breeding herd of cattle, which reduces herd depreciation, since young cattle bred on the farm step into the places of the mature cows which are drafted from the herd on a regular basis when they reach their maximum value. In recognized cattle breeding districts where regular drafting of cows takes place after they have produced their third or fourth calf there is frequently an appreciation in the value of the cattle. This sytem is disturbed sometimes when the fruits of milk-recording are fully recognized, as the tendency in such cases is to sell the non-productive animals and to retain the good producers, irrespective of age. It is necessary to emphasize that preference should be given to breeds that are large yielders of milk, especially where the farm is relatively small in size. On these farms it is customary to sell bull calves at birth for slaughter, and to rear the best of the heifer calves for herd replacement purposes. On larger farms where heifer and steer calves can be reared, dual-purpose breeds are essential, with the emphasis on the milk rather than the beef properties.

Calving Down at Regular Intervals.

The market needs for milk are greatest during



Points of a Dairy Cow.

the winter months, and to this end the prices for winter milk are adjusted to make winter milk production more attractive. It is important therefore that calving should be so arranged to get the greatest production in winter, so as to avoid creating an undue surplus of milk in early summer, which often results from too many cows calving down in spring. The ideal aim should be to have animals calving down at regular intervals the whole year round. This programme is liable to be upset when disease enters a herd and in this respect abortion and sterility are the two worst offenders. Fortunately these related troubles can now be more effectively controlled by veterinary attention. The average size of wholesale milk sellers' herds is 20 cows.

The big collecting companies have developed a local system of collection of milk from the farms in churns holding 10 gallons of milk and for long distance transport the milk is pasteurized at the depots and sent either by rail or road in glass or enamel-lined milk tanks that carry 2,620 gallons of milk (12 tons). This sytem of bulk transport has been the means of effecting economies in cost of transport and labour. The cost of transport of milk from the farm to the dairy is charged to the producer.

The Farmhouse Cheesemaker.

Farm-House Cheese-Production.

In some districts and particularly Cheshire, Lancashire and Somerset prior to the War, farmhouse cheese-production was preferred by a section of milk-producing farmers to selling milk on the wholesale market. In other districts there was some concentration on the making of luxury cheeses like Stilton and small cheeses. As to whether farmhouse cheese-production will ever become generally popular again is open to doubt, since the problem of overseas imports and factory manufacture have to be considered. The success of this system depends largely on the employment of skilled cheesemakers and by reason of the seasonal character of the work this is not satisfactory from the standpoint of cheese-making personnel.

There is not much difference from Wholesale milk production in the farming systems followed, except that the calving of cows takes place in the early months of the year, and particularly from February to May. This ensures that maximum production of milk from April until August coincides with the availability of cheap food in the form of grass, while, for the rest of the year, the cows are maintained chiefly on the produce of arable land. It is customary for breeding herds to be maintained, with the regular drafting of cows when mature. It follows that where skilled labour has to be employed in the manufacture of cheese, the volume of milk produced should be sufficient to justify the expenditure necessary, and so the pre-war size of cheese-making herds averaged 43 cows. The breed

of cow normally kept is of the dual-purpose type, though it is important to recognize that milk of good fat-content is necessary to get the highest cheese to milk ratio.

In pre-war years the Milk Marketing Board encouraged farmhouse cheese-making by means of a grant of approximately 4d. per gallon of milk utilized. The number of participating cheese-making farmers was about 1,200 and they converted just over 20 million gallons of milk a year into cheese. The percentage of milk utilized for the different types of cheeses was:—

Cheshire, 52·0 per cent; Cheddar, 29·6 per cent; Lancashire, 14·2 per cent; Wensleydale, 2·0 per cent; Caerphilly, 0·8 per cent; Stilton, 0·4 per cent; Other types, 1·0 per cent.

A feature of cheese-making farms is their association with pig-feeding, for the purpose of utilizing the whey, which is otherwise difficult to dispose of. In factories, satisfactory processes have been evolved for drying the whey, the product so obtained being utilized for animal feeding.

About 75 per cent. of the cheese consumed in this country is imported, mainly from New Zealand and Canada.

The quality of cheese is related closely to the use of clean milk and in the pre-war period a National Mark scheme obtained for the grading of approved cheeses.

Cream Production and Butter-Making.

Farm-house Butter.

Cream and butter production were formerly a feature of dairying in districts remote from good transport, such as Cornwall and Devon, Wales, the Yorkshire dales, Cumberland and Westmorland. These districts were also associated with the raising of good store cattle, the calves being reared on separated milk. The low price of butter in relation to liquid milk sold in the wholesale market for human consumption and the availability of motor transport even in isolated districts for the collection of milk has very largely eliminated cream and butter production from farmhouse practice. Furthermore the quality of farmhouse butter often left much to be desired when compared with home-produced or imported factory-made produce. The Milk Marketing Board pays grants to butter makers on the gallonage of milk utilized, but factories have been able to utilize such rebates to greater advantage than farmer-producers since they are equipped to dry the separated milk or even to sell bulk quantities of separated milk for industrial purposes at satisfactory prices.

The market for sales of fresh cream could well be developed in this country in the post-war world, but the principal difficulty hitherto has been the high retail price, which has tended to restrict sales. In a possible revival of a concentration on cream production or butter-making, the most suitable breeds for the purpose are Guernseys and Jerseys respectively by reason of their milk being rich in butter fat; and the development of interest in cream production in particular might well be considered by dairy farmers in districts with potentially good consuming markets. Such a development would also have beneficial effects on calf-rearing and pig-feeding through the availability of separated milk.

LABOUR FACTORS AND MILK-PRODUCTION

The efficiency of the labour used and the efficient use of labour are both passed under review. Hand milking is considered fully. There is a discussion of Machine milking.

Good Labour the Key Factor.

Good labour is often the key factor in successful milk-production, while the proper organization and utilization of labour is important in relation to the economics of production. It is always a sound policy in the efficient use of labour that a full load of work should be carried with few idle periods and that adequate provision be made for a reserve of labour to make possible a half-day holiday and periodical week-ends throughout the year. In this respect mixed farming possesses definite advantages, both as regards efficient utilization of labour and the provision of the necessary reserve. In my experience I have found it better to create work on a milk-producing farm by growing crops in order to have a satisfactory reserve of labour than to think entirely in terms of labour economy. Increasingly it becomes necessary to make the job of the worker engaged on milk-production attractive instead of its being a mere drudgery which it is apt to be under unsatisfactory conditions.

On many farms the lay-out is far from ideal for the most economical production of milk. Not all farms are in a ring fence and if cows have to be driven a long distance from the cowsheds to their grazing, expensive labour should not be used if cheaper labour is available. Existing farm buildings are not always ideal as far as the arrangements for storing foods, mixing rations and feeding stock are concerned, and one can appreciate the attitude of those who have overcome these difficulties by the practice of bail milking, which literally means that the conveniences for milking are taken to the fields. If the milk-producer is to become increasingly efficient, more attention will have to be given to dairy farm lay-outs and this must be considered as much from the labour standpoint as from any other.

The efficient use of labour is also concerned with the efficiency of the farming system. Low yielding herds tend to be extravagant in labour costs. There are possibilities of better organization in herds of adequate size, though, taking this country as a whole, family labour is utilized widely on milk-producing farms. Family labour is invariably the most efficient form of labour, for the simple reason that a man is generally prepared to do more for himself than for anybody else.

The efficiency of the labour itself is important. Poor labour means lower yields per cow and lower butter-fat percentages, but even good labour should not be penalised by lack of adequate facilities for doing work well. The use of milking machines has increased by reason of labour difficulties, but machines require intelligent operators if they are to give satisfaction.

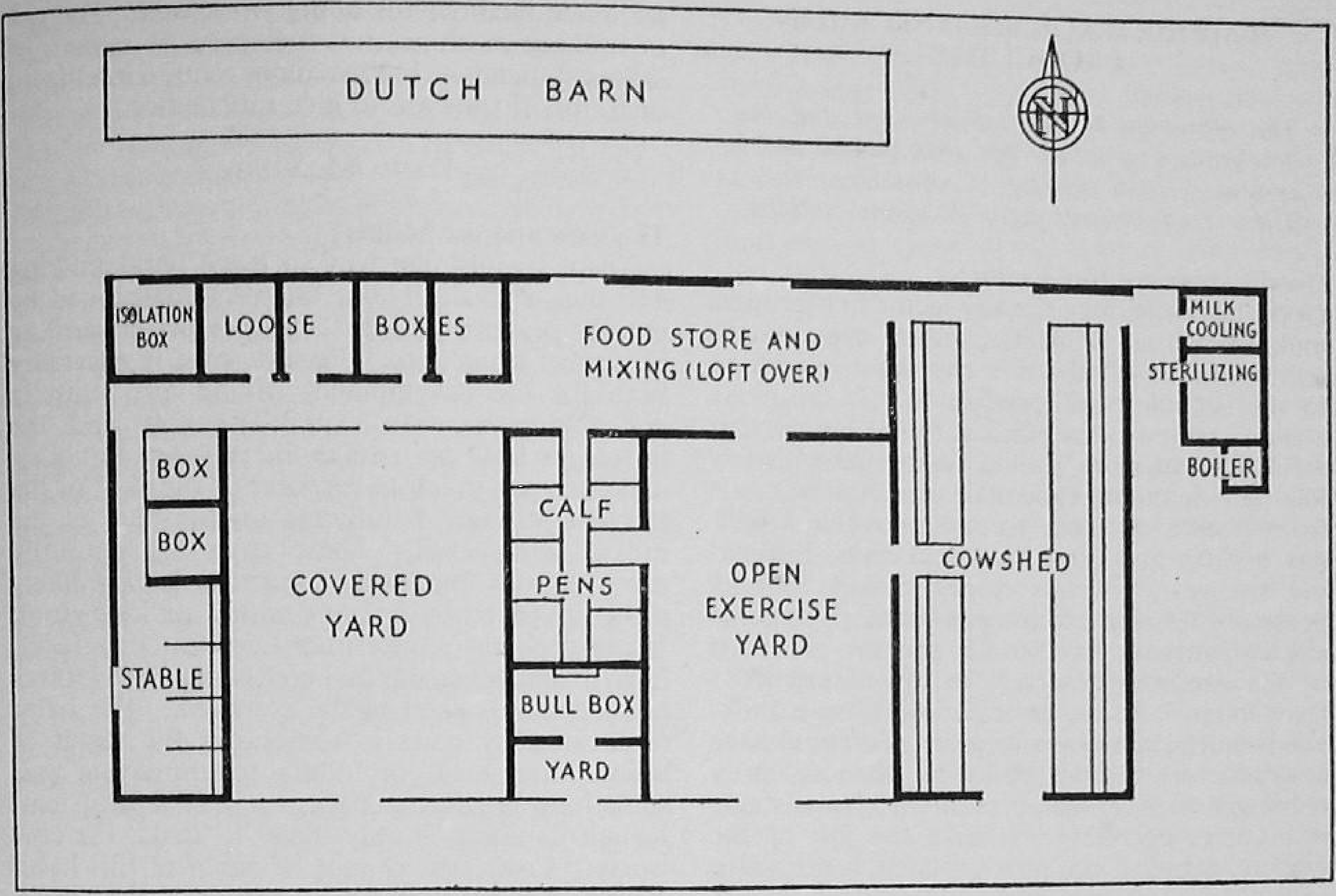
Hand Milking.

The Cow and the Milker.

There is only one way to learn hand milking and that is to do it, but the art is developed by regular practice and by a proper understanding of correct procedure. Perseverance is necessary both for the development of the arm muscles and for increase in skill. The cow and the milker are both partners in the process of milking and cows are quick to respond to the skill of the efficient milker. Kindliness on the part of the milker is essential. Some cows are naturally more nervous than others, but they are not likely to be improved by flogging with a milking stool. Many problems concerning nervous cows result from mismanagement and cool-tempered workers are a priceless asset in the cowshed. The habit of kicking by cows is sometimes the result of unkind treatment, or failure to appreciate that something is causing pain, such as a sore teat. Rough handling is only likely to make the cow worse. Cows that cannot be cured of this habit should have their legs tied with a leather strap that is put around one leg above the hock and put through a loop and then fastened round the other leg so that movement is restricted. In summer, flies are apt to cause uneasiness during the milking process with the consequent switching of cows' tails, but this can be overcome by spraying the cows before milking with one of the recognized fly sprays.

The method of hand-milking that secures the most efficient results is to press gently on the fore teats until the milk begins to fill in the teats and then with the fingers about three parts round the teats, pressure should be applied to draw the milk from the teats. There is no need for any vigorous down pulling action. There should be little perceptible arm movement beyond the relaxation and tightening of the fingers and the object should be to get a full stream of milk as quickly as possible, milking rapidly, yet gently. The skilled milker is able to keep hold of the teats until the last drop is drawn and it is important to get the last drop both for maximum yield and high butter-fat percentage. It is customary to milk the fore-quarters first and then to proceed to the rear quarters. There is no particular reason for this order except that it tends to maintain a more even shaped udder. It so happens that the hind quarters of the udder secrete slightly more milk than the fore-quarters and as milking capacity is induced by thorough milking, there is a natural tendency to go back to the fore-quarters in the stripping process after the rear quarters have been emptied.

The method of stripping with a good cow is to



PLAN OF DAIRY FARM LAY-OUT.

milk until there is no flow from the teats. In some cases it is customary gently to massage the quarters with one hand just before the completion of the milking process. Drawing the finger and thumb down the length of the teats and extending the teats in the process is not desirable.

Dry handed milking should be insisted upon from the standpoint of clean production, and the milker should always have clean hands and short finger nails.

Milking Machines.

Machine milking has long since passed the experimental stage and it is now widely practised as a part of the routine of large-scale milk production. Normally milking machines are installed on the dairy farm as a means of overcoming labour difficulties. Investigations show that machine-milking reduces labour requirements by about 50 hours per cow per year, but this only begins to be important in the larger herds. In normal herd management one man is required for every 12 cows in the milking herd for ordinary labour needs, so that two men would be required to a herd of 24 cows, assuming 20 to be in milk. It is not a practicable proposition to work such a herd with less labour. When there is a greater number of cows than this the machine becomes a worth-while investment if further suitable labour cannot be obtained. It is a common experience to find that once a machine is installed the size of milking herd is increased, and this is economically sound, provided the farm can carry the extra milking cows.

The successful operation of machine milking is largely dependent on intelligent management by the labour in charge of the machine. The manufacturers of milking machines are concerned that their users should have complete satisfaction and the instructions should be followed carefully. The best results in the handling of machines are generally in those herds where the owner supervises the milking operation himself. The change-over from hand to machine milking is usually attended by uneven responses from the cows in the milking herd. Heifers and newly calved cows adapt themselves more readily to the use of the machine, but there are some animals that do not respond and quickly dry off. At the Midland Agricultural College five years machine-milking comparison with five years of hand milking showed a definite reduction in yield with machine-milking and a lengthening of the dry period per cow.

"No Machine, No Milk."

Many erroneous ideas obtain about the actual savings effected by machine-milking. To be most effective, the herd in which it is utilized should normally employ three or more hand-milkers, so that some labour can be dispensed with at milking time. On a mixed farm the labour disposed of must not necessarily be regarded as dispensable. The farmer who dismisses a man to justify the

machine often suffers from shortage of labour on other sections of his farming enterprise. The machine makes it possible to concentrate workers on essential work at busy periods of the year like root-singling and harvest. It facilitates the provision of a rotation of week-ends off duty and is a precaution against labour shortage created by natural conditions or sickness. Indeed under ordinary large-scale milk-production it is difficult to conceive of dairy farming being carried on in many parts of the country without the machine; so that the problem is reduced to the simple one of " no machine, no milk." The use of a machine does not reduce the actual length of the milking process and it must not be overlooked that the cleaning and sterilization of machine-milking units takes more time than the cleaning of hand-milking equipment.

There are a few fundamental points that should be noted with regard to the installation, operation and management of milking machines. There is no reason to believe that any one of the well-known types is better than another in efficiency. The running costs however differ, and electrically operated plants are cheaper to maintain than those driven by petrol or paraffin engines, and are much freer from trouble. In most average-sized machine-milked herds, four units are operated, by two workers. Differences of opinion occur as to whether it is necessary to strip the cows after machine-milking by reason of the time taken and the risk of contaminating the milk, but the concensus of good practical opinion is against hand stripping after the machines have been removed. American experiments on this subject have indicated that a satisfactory form of stripping with machine-milked herds is secured by gentle hand manipulation of the udder and pulling downwards on the teat-cups. The result of this stripping was the equivalent of a return of $5\frac{1}{2}$ gallons of milk for an hour's hand labour. It is obviously good business to use labour for a return of this kind. All good users however are agreed that with the majority of cows, the units should not be left on the udder for longer than four or five minutes. When machines are used, care has to be taken that units are not transferred from cows suffering from mastitis to healthy cows. To this end it is important to draw the fore-milk (two or three draws) onto a strip cup before milking begins. The appearance of clots in the milk is a danger sign and such cows should be milked last.

GOOD MILK-PRODUCTION

After explaining how important good milk is in relation to the health of the community the production of milk of good keeping quality is expounded. The importance of cleanliness in the management of the cowshed is emphasized. There is a section of the section on Cleanliness of the cows. *In turn our author deals with* Cleanliness of the milkers, Cleanliness of the utensils *and* Cleanliness of Production. *The Equipment for Milk Production is next discussed and the Importance of good water supply is demonstrated. After dealing with the question of the Disposal of Milk, Prof. Robinson gives us the Special Designations of Milk:*—(1) *Tuberculin-Tested Milk*, (2) *Accredited Milk*, (3) *Pasteurized Milk*, (4) *The Attested Herds Scheme, explaining each fully. The section is brought to a close with a discussion of The Establishment of a Tuberculin-Tested Herd.*

The Production of Milk.

THE importance of milk in relation to public health has necessitated legislation to safeguard the community, for which reason milk-producers aie under an obligation to satisfy certain minimum legal requirements before they are permitted to engage in milk-production for sale. Producers are required respectively to be registered with their Agricultural Executive Committees and with the Milk Marketing Board. The Agricultural Executive Committees are concerned with such matters as the suitability of the cow-sheds and dairies—the suitability of the water supply, the cleanliness of the sheds and utensils, and the practice of methods calculated to ensure the production of milk of good keeping quality.

Prior to 1949 this function was the responsibility of the local authorities, but the transfer to the Ministry of Agriculture has ensured uniformity of interpretation of the Milk and Dairies Order.

War-time needs emphasized the importance of avoiding waste of milk through souring and in 1942 the National Milk-Testing and Advisory Scheme was introduced by the Ministry of Agriculture with the co-operation of the Milk Marketing Board and the Milk Distributive Trade. This scheme initiated regular tests of the keeping quality of all milk that enters the wholesale and retail markets. These tests are, in effect, a check on the efficiency of the methods of production on each farm. Failure to attain a desirable standard in respect of good keeping quality leads to a checking up of the methods of production, on the farm in question, by the dairying staff of the County Agricultural Committee with a view to giving advice for the improvements necessary.

As good milk obviously implies healthy milk, milk-producing cattle are inspected by Government Veterinary surgeons at least once a year. In addition to this the Ministry of Agriculture has done much to foster the scheme for the control of diseases in dairy cattle that was brought into being under the auspices of the National Farmers' Union and the National Veterinary Medical Association.

HOW TO PRODUCE GOOD KEEPING QUALITY MILK.

Bacteria can be Checked.

The factors responsible for the rapid souring of milk after production are bacterial contamination and the failure to prevent the rapid multiplication of these organisms after the milk has been produced. It is essential to recognize therefore that conditions must be provided in the cowshed to limit the intrusion of bacteria to the milk at the time of production and to appreciate at the same time that after production the multiplication of bacteria can be checked by cooling the milk adequately and keeping it cool until it is delivered to the consumer. Once these two points are appreciated, a better understanding will obtain concerning the provisions of the Milk and Dairies Order with regard to the sanitation of cowsheds and general milk-production hygiene. It should be emphasized however that it is not so much the buildings that matter as the methods that are employed, and that each member of the cowshed staff has a personal responsibility, since one careless individual is sufficient to undermine the efficiency of those who take the necessary care.

CLEANLINESS OF THE COWSHED.

Matters of Detail.

Dirt and dust are the chief causes of bacterial contamination, and cowshed routine should be organized so that these are reduced to a minimum. Herein lies the importance of well-lighted and well-ventilated sheds, for it is essential that sheds should be clean and sweet. Dark conditions are likely to hide much dirt. The walls and ceilings should be limewashed or disinfected at least twice a year, while the daily routine should provide for the removal of the dung and soiled litter, and the swilling down of the gangways and walls splashed by manure and the rear part of the standings. The periodical removal of dust from the beams, rafters, window ledges and stall divisions is also desirable, but any operation that involves the creation of a dusty atmosphere such as foddering with hay should not be done immediately before milking. Clean mangers are similarly important and these together with the water bowls, stall divisions and feeding passages should be cleansed periodically. These are all matters of detail, but collectively they have

an important bearing in creating a dust-free atmosphere.

CLEANLINESS OF THE COWS.

A Daily Routine.

Cows maintained in clean, light and well-ventilated sheds tend to be healthier and therefore more productive, but the cows themselves must be as free from dirt as possible. The principal aid to cleanliness is regular grooming with a curry comb and dandy brush, which ensures clean skins and freedom from accumulations of manure in the region of the hindquarters and thighs. The tendency for dung to adhere to the hindquarters, thighs and tail in winter can be avoided if the hair is removed by a horse-clipper in these parts at the beginning of winter, especially when cows are to be confined in cowsheds. The use of a dandy brush dipped in water quickly removes any adhering manure. Grooming should be a daily routine, usually performed about two hours before the afternoon milking. Long hairs on the udder should also be removed by a clipping machine, and prior to milking the udder should be washed. It is customary to have two pails of water with two good sized cloths. The first pail and cloth are used for the preliminary soaking and the second pail and cloth for drying the udder. The water in each pail should be changed when it becomes dirty. It is now customary for a disinfectant solution like Deosan to be incorporated in the washing water, while it is important to sterilize udder cloths and washing pails periodically.

The final operation in the preparation of the cow for milking is the taking of two or three draws of milk from each teat into a teat cup. This practice not only detects cows that are starting with mastitis but also eliminates bacteria which tend to accumulate in the ends of the teats between milkings.

CLEANLINESS OF THE MILKERS.

A Desirable Standard of Cleanliness.

Having ensured that the cows are as free from dirt and dust as possible, it is equally essential that those responsible for the milking process have clean clothing and clean hands. A white cap and washable overall are now a more or less routine equipment in all cowsheds, and the milkers wear these overalls after they have completed grooming and any dirty work. The overalls are changed weekly for clean sets. The provision of a wash basin with warm water and soap and a clean towel in the milk receiving room enables the milkers to maintain a desirable standard of cleanliness during the milking process. It is a good habit to wash the hands before milking each cow. Where hand milking is practised, the lowest bacterial counts are obtained by milking with dry hands.

CLEANLINESS OF THE UTENSILS.

Clean Milking Utensils.

Clean cowsheds, clean cows and clean staff, important as they are, also demand clean milking utensils. These utensils comprise all the apparatus used in the production, straining, cooling and storage of milk, and in this connection one has not to forget the importance of clean milking stools in hand-milked herds and clean pipe lines in machine-milked herds. Many poor-keeping results are due to defective cleaning of these various utensils, so that washing up after milking is just as important an operation as milking itself.

A standardized routine on most good dairy farms is thoroughly to rinse all milking utensils in cold or tepid water as soon as milking is finished. This prevents the milk from drying on the utensils and becoming more difficult to remove. Thereafter the milking equipment should be scrubbed in hot water, preferably using some cleansing detergent, such as soap or washing soda at the rate of 1 oz. to 3 gallons of water to remove grease. It is specially important to rinse the milking utensils well in clean water after this treatment.

Each utensil after washing should be placed upside down in the chest of the steam sterilizing outfit and when the washing is completed the door of the sterilizer chest should be closed and the steam turned on. A temperature of 210°F. should be maintained for fifteen minutes, after which the door of the chest should be opened immediately to prevent condensation, and to allow the utensils to dry. A piece of clean muslin to cover the opening of the chest will protect the utensils from dust and flies. In the case of churns which are not normally sterilized in the cabinet, these are placed over a special steam jet, which is available with most sterilizing outfits, for a period of 3 minutes after the lower portion is too hot for the hand to bear. It is of the utmost importance that milk producers should recognize their own responsibilities in the matter of clean churns, notwithstanding the buyers' obligations to provide clean churns. To be on the safe side, producers should thoroughly sterilize all churns. The milking utensils are best stored in the sterilizing cabinet until milking time.

In the absence of a steam sterilizing outfit, which is the most effective method of keeping bacteria down to a minimum, the immersion of each utensil in a large copper of boiling water is satisfactory once the equipment has been washed thoroughly. A recent development is the use of chemicals that are solutions of sodium hypochlorite, but while these are satisfactory makeshifts they are not so reliable as steam sterilization and are also apt to cause rusting of the utensils.

Routine Practice.

Where milking machines are used, special

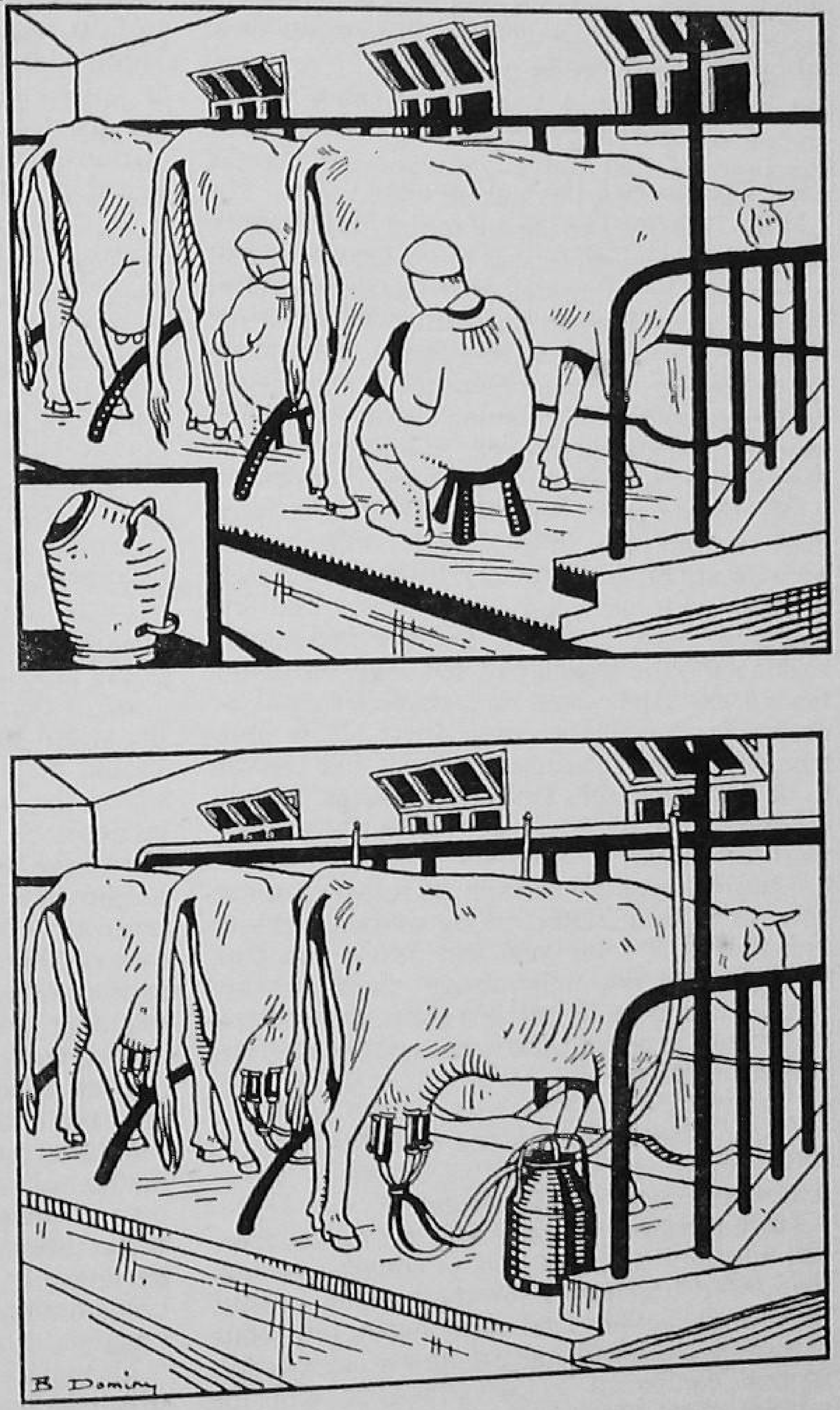
precautions are necessary for the maintenance of cleanliness. As soon as milking is finished any extraneous dirt should be washed from the units and then 2 gallons of clean cold water should be drawn through each unit, the four teat cups being plunged in and out at intervals, so that all traces of milk are removed from the insides of the tubes. This treatment is followed by drawing water at 180° F. containing a recognized detergent through the units. All the internal surfaces of liners and tubes should be brushed with the appropriate brushes, in hot water, and then finally rinsed in hot water and sterilized. This sterilization is done by plugging the end of the long milk tube on to a steam jet that is situated at least 6 feet from the boiler; the steam is then turned on slowly and passed through the assembled units for three minutes at a temperature of 210 to 212°F. The complete dismantling of the units should be done weekly, and it is found that the teat cup liners last longer if they are rested, so that it is satisfactory to have two sets, each being rested in alternate weeks. Equally important as a routine practice is the periodic cleaning of the air lines.

Cleanliness of Production.

Care in Production and Management.

Clean sheds, clean cows, clean workers and clean utensils demand one further requirement and that is care in the production and management of the milk from the cow until it reaches the churn. The fore-milk will have been removed before milking begins, but when hand milking, the covered pail should be used to restrict the access of dirt, and as soon as each cow is milked, the milk should be taken to the dairy where it is passed through the strainer and then over the cooler. Milk should never be allowed to remain in the cowshed longer than is absolutely necessary before being cooled. Straining is necessary to remove any dirt or hairs that may accidentally gain access to the milk, but contrary to popular opinion it is not a means of reducing bacteria, which pass through with the milk.

In the case of machine milked herds the management during the milking process for maximum cleanliness requires the units to be carried with the teat cups hanging downwards, and to ensure that when the teat cups are being fitted to the cow, there should be the minimum opportunity provided for the teat cups to suck in air. In the case of units falling off the cow on to a contaminated floor, the teat cups should



Hand and Machine Milking.

be washed in clean water before being reapplied to the cow. Where stripping is practised in machine-milked herds, the same precautions are necessary as those applied in hand-milked herds.

A Legal Requirement.

It is a legal requirement that milk should be cooled to within 5°F. of the temperature of the

cooling water. A cooler protected by covers is ideal, but failing this the cooling room should not be exposed to dust, otherwise contamination of the milk is likely to occur.

Thereafter the milk should be kept as cool as possible and if it is necessary to leave the churns on a roadside platform for picking up by the collecting firm, a thatched roof over the platform serves to control the temperature adequately during hot sunny weather.

Equipment for Milk-Production.

Select Utensils on a Basis of Quality.

Much progress has been made in recent years in the manufacture of milk utensils that are simple to clean and therefore well suited to the needs of modern milk-production when good keeping quality is of primary importance. Buyers of new equipment should select utensils on a basis of quality rather than studying merely the first cost. Heavy gauged and heavily tinned seamless utensils with rounded corners should be preferred to the cheaper types that wear out or rust more quickly. Polished stainless steel utensils are ideal, but are generally too expensive for ordinary needs.

Milking buckets of the old-fashioned open-topped type are being superseded by the seamless covered pails, and although these are not so convenient to use from the milker's angle, they limit the amount of dirt which can gain access to the milk and are therefore to be preferred. The equipment for receiving the milk in the dairy comprises the receiving tank, on the top of which is a strainer, and the milk in turn flows over a cooler into the churn. The main point to observe with the receiving tank is that in construction it should be easy to clean and sterilize and of a size large enough to take the milk from the herd without any hold-up. Manufacturers have made satisfactory modifications of the taps to facilitate easy cleaning and they provide covers for the top of the tank. The best type of strainer is that which fits into an aperture in the cover of the receiving tank, and where the straining is done through cotton-wool filter pads that are destroyed after each milking and are held between discs of perforated metal. Some strainers incorporate the use of cloths, but these are a source of trouble in the absence of efficient sterilization.

The cooler is an important utensil that has been modified by manufacturers in recent years to harmonize with the experience of dairying experts. In order to facilitate cleaning, the corrugations should be wide enough for all the surface area to be reached with a finger while the ends should have no corners that cannot be cleaned. Progress has also been made in milk churns and those of 10 gallons capacity made in one piece and free from seams are used almost universally. Churns of this size are more easily handled and carry a greater volume of milk for the floor space occupied, as well as being easier to clean and sterilize than the churns used formerly which held 17 gallons. In most cases the churns are supplied by the companies purchasing the milk from the producer.

Importance of Good Water Supply.

Good Water Supply Necessary.

The limiting factor in relation to the production of milk of good keeping quality on many farms is the adequacy of the water supply. A good water supply is necessary for the maintenance of good health in the dairy herd, for the cleaning of cow-sheds and utensils and the proper cooling of milk. Difficulties sometimes arise in summer because piped supplies do not allow for an adequate reduction in milk temperature after it has passed over the cooler. To meet this difficulty it is now possible to instal small refrigerators that are associated with the normal cooling mechanism, and this enables a better control to be maintained on cooling temperatures. In practice however, these refrigerators are of more importance to producer-retailers. One cannot visualize satisfactory milk production on farms where a deficient water supply exists. During the war, Government grants were made available through War Agricultural Committees to farmers for the improvement of water supplies on dairy farms and these provisions have been continued.

The Disposal of Milk.

When Milk is Sold.

When milk is sold to one or other of the collecting companies the responsibility of the producer for the supply of milk of good keeping quality extends until the milk reaches the collecting depot. This system cannot well be avoided and if milk is produced under proper hygienic conditions it is not likely to give rise to any difficulty about deterioration in keeping properties even in hot weather. It may happen that delay in collection and long exposure to the sun in summer will reduce good keeping properties when milk is seriously contaminated in the course of its production.

When milk is distributed retail by the producer it is important to ensure that satisfaction is given to customers by supplying milk that will keep. Milk produced under proper conditions should keep sweet for at least two days in summer and at least double that time in winter. The old system of delivering from a churn or pail into the customer's jug or can is not satisfactory under the producer-retailer system and has been largely superseded by the distribution of milk in sealed glass bottles or even cartons. Though expense is incurred in the supply of bottles or cartons, there is a saving effected in the limitation of loss by spillage and the greater accuracy of measuring deliveries to customers.

Special Designations of Milk.

Designated Milks.

For some time it has been the policy of the Government to encourage the production of milk that is safe from the standpoint of human nutrition. Legislation has been enacted to bring all milch cows in dairy herds under State supervision from the standpoint of animal health, and special encouragement is given to dairy farmers to produce milk from tuberculin-tested animals.

Under the Milk (Special Designations) Order, 1936, the following provisions are made for designated milks:—

1. *Tuberculin-Tested Milk.*

Producers qualifying for this designation have to obtain a licence from their Licensing Authority (i.e. County Council or County Borough) and must satisfy the undermentioned requirements:—

(*a*) that every animal in the herd has been subjected to the tuberculin tests at six monthly intervals;

(*b*) that every re-acting animal has been removed from the herd;

(*c*) the submission of a Veterinary Surgeon's certificate as to the general health of the herd;

(*d*) the suitability of the arrangements for producing milk, including the structure and cleanliness of buildings, cleanliness of milking arrangements and sterilization of utensils:

(*e*) the attainment of a satisfactory standard of cleanliness of the milk produced, as judged by the results of laboratory tests.

2. *Accredited Milk.*

Producers desirous of obtaining a licence to become accredited milk producers must apply to their local Licensing Authority and satisfy the following conditions:—

(*a*) the submission of a Veterinary Surgeon's certificate as to the general health of the milch cows in the herd.

(*b*) the same conditions as contained in (*d*) and (*e*) of the Tuberculin-Tested Milk scheme.

3. *Pasteurized Milk.*

This designation does not at the moment affect producers or producer-retailers, but provisions have been made in legislation already approved for the extension of the system of treating milk by the process of pasteurization or heat treatment, which when efficiently carried out renders milk containing disease-causing organisms safe for human consumption, and also extends its keeping properties. Wherever milk is handled in large quantities and supplies are drawn from many sources, pasteurization is essential.

The Attested Herds Scheme.

This is not a designated milk, but provides facilities for the production of Tuberculin-tested milk. This scheme is under the direct control of the Animal Health Division of the Ministry of Agriculture and in order to qualify for a certificate the following conditions have to be fulfilled:—

(*a*) the herd must pass two tuberculin tests at an interval of not less than 60 days and not more than 12 months without reactors being found;

(*b*) all animals in the herd must subsequently pass an official tuberculin test made by a Veterinary Inspector of the Ministry of Agriculture; subsequent tests are carried out at intervals ranging from 60 days following the disclosure of reactors or doubtful animals up to 12 months if no reactors have been found; and

(*c*) the management of the herd and the conditions under which it is kept must conform to the Rules of the Attested Herds Scheme.

Milk-producers who can satisfy the requirements of the Attested Herds Scheme or who produce Tuberculin-tested milk receive a bonus of 4d. per gallon. Accredited producers receive a bonus of 1¼d. a gallon.

The Establishment of a Tuberculin-Tested Herd.

Cleaning-up of Herds.

Many animals are infected with tuberculosis without showing any of the active symptoms of the disease, but in such cases the trouble may flare up in an active form without warning. Encouragement is now being given to the cleaning-up of herds by the extra bonus of 4d. per gallon allowed for milk from tuberculin-tested herds and fortunately the disease can be eliminated by the adoption of common-sense methods.

The ideal of a tuberculin-tested herd should be the ambition of every progressive dairy farmer, but it is achieved most easily where a self-contained breeding herd is kept and where there is the possibility of freedom from infection from other cattle. The first essential is a suitable farm with good buildings. Farms that are within a ring fence, with independent water supplies and with well-ventilated buildings that can be properly cleaned provide ideal conditions.

The Exercise of Care.

The first steps in ridding the herd of tuberculosis are the testing of the cattle in the herd with tuberculin under veterinary control, and the isolation of re-acting animals from the rest of the herd. The least inconvenience is caused where two farms are available, one to be used for clean cattle and the other for reactors. It is possible however to clean up on one farm, provided separate pastures and buildings are available for the segregation of reactors. The chief source of infection on established farms is the buildings; so the exercise of care in disinfecting cowsheds,

and other buildings used for clean stock is fundamental to success. Pastures may be infected, but the risk is not so great as with buildings and the policy of ploughing-up the pastures in close proximity to the farm buildings and re-seeding direct is a worthwhile precaution.

The immediate removal of calves at birth, even from reacting cows, is likely to be satisfactory and young stock that are tested are best kept by themselves so that they do not make contact with older animals. Until the whole herd is clean, manure from the cowsheds should not be returned to grassland on which animals are to graze but should be applied to arable fields.

Disposal of Reactors.

The disposal of reactors at the commencement of a cleaning-up policy is best done when the animals have finished their lactation and can if desired be fattened off, or if suitable isolation facilities exist they may be retained until such time as they are eliminated and clean, home-bred young stock are available to take their place.

The beginner in dairy farming is strongly recommended to start with tested animals, preferably purchased from an attested herd, but it is necessary that such animals should be placed on clean pastures and in clean buildings. To this end, where farms are taken over with a Lady Day date of entry, it is a wise precaution to take hay from the permanent grassland before stocking with cattle.

THE BREEDING OF DAIRY CATTLE

This subject is dealt with under the following headings: The Foundations; Constructive Breeding; The Influence of the Bull; The Influence of the Female Stock.

THE FOUNDATIONS.

THE finest agricultural picture in the world is the parade of live-stock that is held in the large ring at every Royal Show. At the centenary Royal Show at Windsor in 1939 there were eleven breeds of horses, twenty of cattle, twenty-three of sheep and eleven of pigs, all developed in this country with the exception of Percheron horses and Friesian cattle.

A Wealth of Material.

Where did they all come from and how did they arrive at their present distinctive forms? No other country has such a wealth of material in the livestock world. This country, however, has had a very mixed history and by reason of the successvie invasions not only were fresh human races introduced, but fresh kinds of livestock also were imported. The human race throughout its history has been attached to certain animals and it is quite typical that on emigrating to another part of the world, the livestock taken from the old country to the new is a reminder of home. Crops are not quite so personal. The animal is different, it is alive in the manner in which we are alive.

Charles Darwin in "The Origin of Species" (1859) attempted to explain the origin of our breeds and types. He asserted that new species evolved from those already in existence, such development being influenced by variation, selection and the survival of the fittest. It can be assumed however that our cattle types today reflect the efforts of man to mould and shape what he found and we know that the foundations of improvement began with the example of Robert Bakewell, who farmed at Dishley Grange, near Loughborough, towards the end of the 18th century; he is known as "the father of livestock improvement." Livestock improvement is due only in part to man's efforts as a breeder, for what has been accomplished would not have been possible without corresponding improvements in agricultural conditions generally. Livestock improvement developed with the better cultivation of grass and crops and there is much truth in the old Lincolnshire saying that "most of the pedigree goes in at the mouth."

Natural, Controlled and Accidental Factors.

The forces responsible for the development of our breeds include natural, controlled and accidental factors. Environment and food are natural factors. Both can exercise a good influence or a bad. Animals can be so mollycoddled and fed on artificial diets that they lose the valuable properties of hardiness and thriftiness. Good balanced feeding of the young calf makes a great difference to the conformation of the mature cow. A calf that is improperly reared and starved in the first few months of life tends to develop features associated with a nondescript scrub animal. Having laid good foundations it is important to know that our cattle shall withstand the natural conditions under which they are expected to live. Banish hardihood, and hardiness is banished with it.

The general practice of breeders in the past has been built upon the influence of heredity; and this is popularly expressed by saying that "like tends to beget like." It is argued that if natural selection produced the types of animals as they are found naturally, then controlled selection enables such further modifications to be effected as will lead to the development of types that harmonize more closely with the requirements of every-day farming. Controlled selection, in turn, emphasized the necessity for the careful selection of breeding material, aptly described in the saying that the "best only can produce the best."

Selection of Breeding Material.

It was Bakewell who first gave breeders the ideals of controlled selection of breeding material. He first of all fixed in his mind the ideal type of animal that he wished to develop. His chief concern was with the development of better meat-producing animals, and his improved Leicester sheep and Longhorn cattle were the result. He also recognized that even if he had the best possible foundation stock, by the ordinary methods adopted in his day there was no guarantee that the progeny would be as good as the parents. He reached the conclusion that the simplest way of fixing what he wanted was the mating of animals closely related to one another, but he was careful in the choice of his foundation stock and he travelled widely in search of what he wanted. His further contribution to progressive breeding practice was the demonstration of the merits of the proven sire. Bakewell was fortunate in finding an unexplored field in which to work, but it was equally fortunate for livestock breeding in this country that a considerable body of disciples in various parts of the country sought to emulate his example; and out of it all evolved our pure-breeding or pedigree methods which are the essential result of keeping improved types.

The breeder of today has a clear understanding of some of the problems associated with breeding which were not understood by Bakewell or his contemporaries. This is an outcome of the discoveries on hybridization made by an Austrian monk, Gregor Mendel. Mendel provided clues to those irregularities in breeding practice wherein like does not always beget like; his theories indicated the reasons for variations and shewed

that they occurred in an orderly and mathematical manner. Resulting from these discoveries the science of genetics has become an important study in human, plant and livestock heredity and scientists have used the knowledge accumulated to good effect in sorting out many of the problems of inheritance associated with livestock breeding.

Constructive Breeding.

Up to Pedigree Status.

The pioneers of livestock improvement desired to create something better than the common stock they found. Having done so, they sought to perpetuate the types in question by founding herd-books for recording the ancestry or breeding of animals. Each improved type or breed of cattle has its own Society and herd-book, but only a small percentage of animals is registered. It must be emphasized that whenever an interest is taken in livestock improvement this suggests a policy of pure-breeding or grading-up to pedigree status by the use of pedigree bulls on approved foundation cows. Membership of a breed society imposes an obligation to keep an accurate record of the breeding practised in a herd. Thus, registered cows must be mated with a registered bull; calves must be ear-marked and their date of birth notified to the society; cows must be milk-recorded and tested for butter fats. Recording breeding is an aid to the attainment of greater uniformity both in type and performance, but pedigree breeding can be abused, and especially when the lineage is worshipped independently of the commercial qualities possessed by the animal.

A Student of Production.

Successful stock-breeding necessitates a good eye for stock. Careful selection of foundation animals has always been the key-note of success in every notable breeding enterprise. All good breeders set themselves an ideal, but it is important that the ideal be correctly conceived. The perfect animal is often a breeder's dream, and in coming down to everyday problems the correction of faults is not a speedy process. The ideal of uniformity in type is fostered by the standards imposed by breed societies. Beyond this it is the duty of the individual breeder to establish a herd, the representatives of which shall be as uniform as peas in a pod. In beef production the conformation and fleshing properties of the breeding stock are a straightforward guide to actual achievement. In the milk-producing animal there is no such certainty that type is correlated with satisfactory yielding properties. Only when a knowledge of production belongs to every animal can success be achieved in breeding milk-producing animals. The breeder of dairy cattle must be a student of production first, and in the breeding of pedigree dairy cattle those pedigrees are good which emphasize the capacity of the strain to transmit good yielding properties both in respect of quantity and quality of milk. The sooner this point is appreciated by all breeders of milk-producing cattle, independent of the breed concerned, the more rapid will progress be, and the more worth-while the ideal. Fleshing-properties are far more easily fixed than are milking-properties and the results of the show-ring have not always been helpful to the breeders of milk-producing animals, for too often the pretty show-yard winners take the eye because of their symmetry and fleshing properties; particularly is this true of classes for bulls and heifers.

The Influence of a Bull.

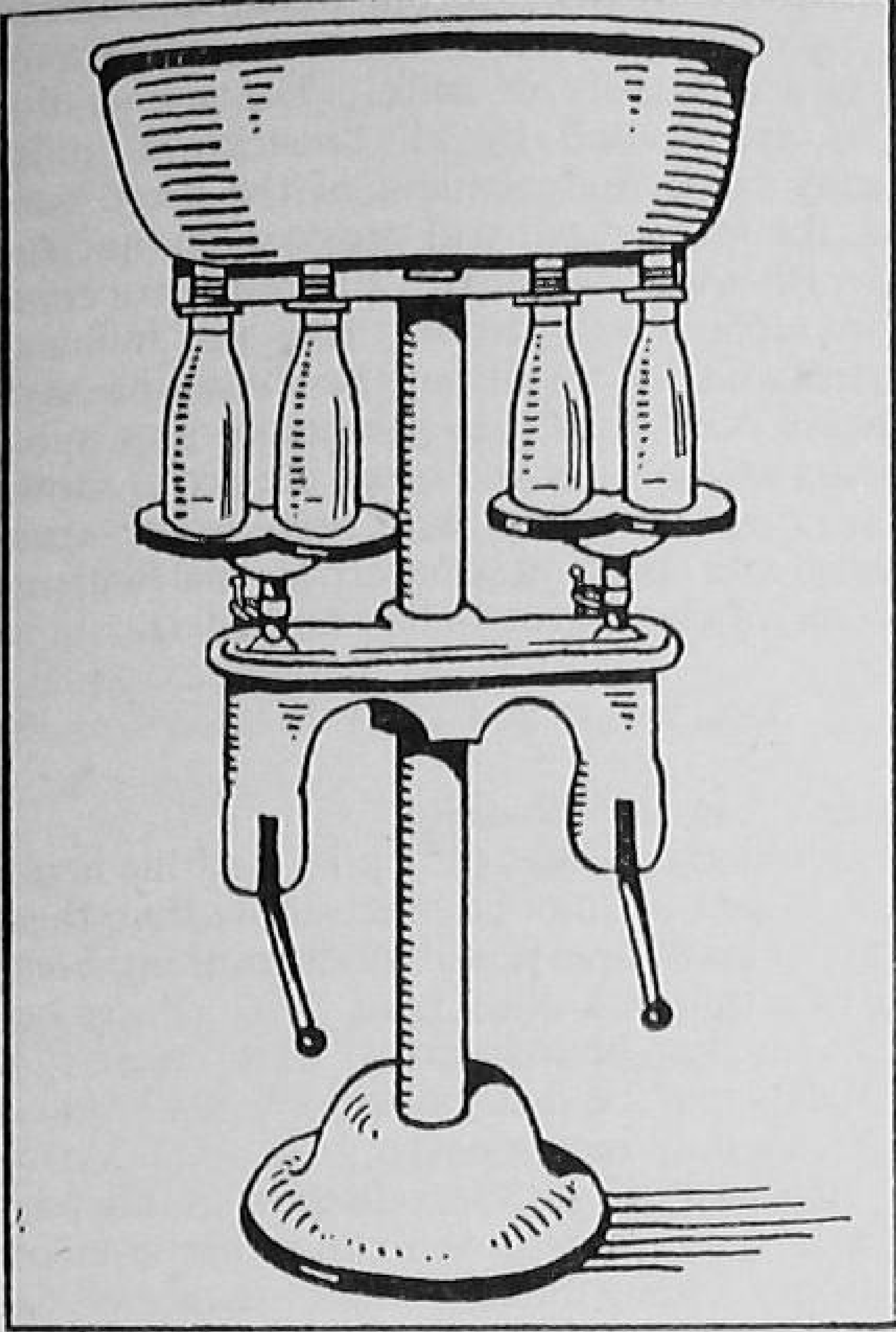
Uncertainty can be Reduced.

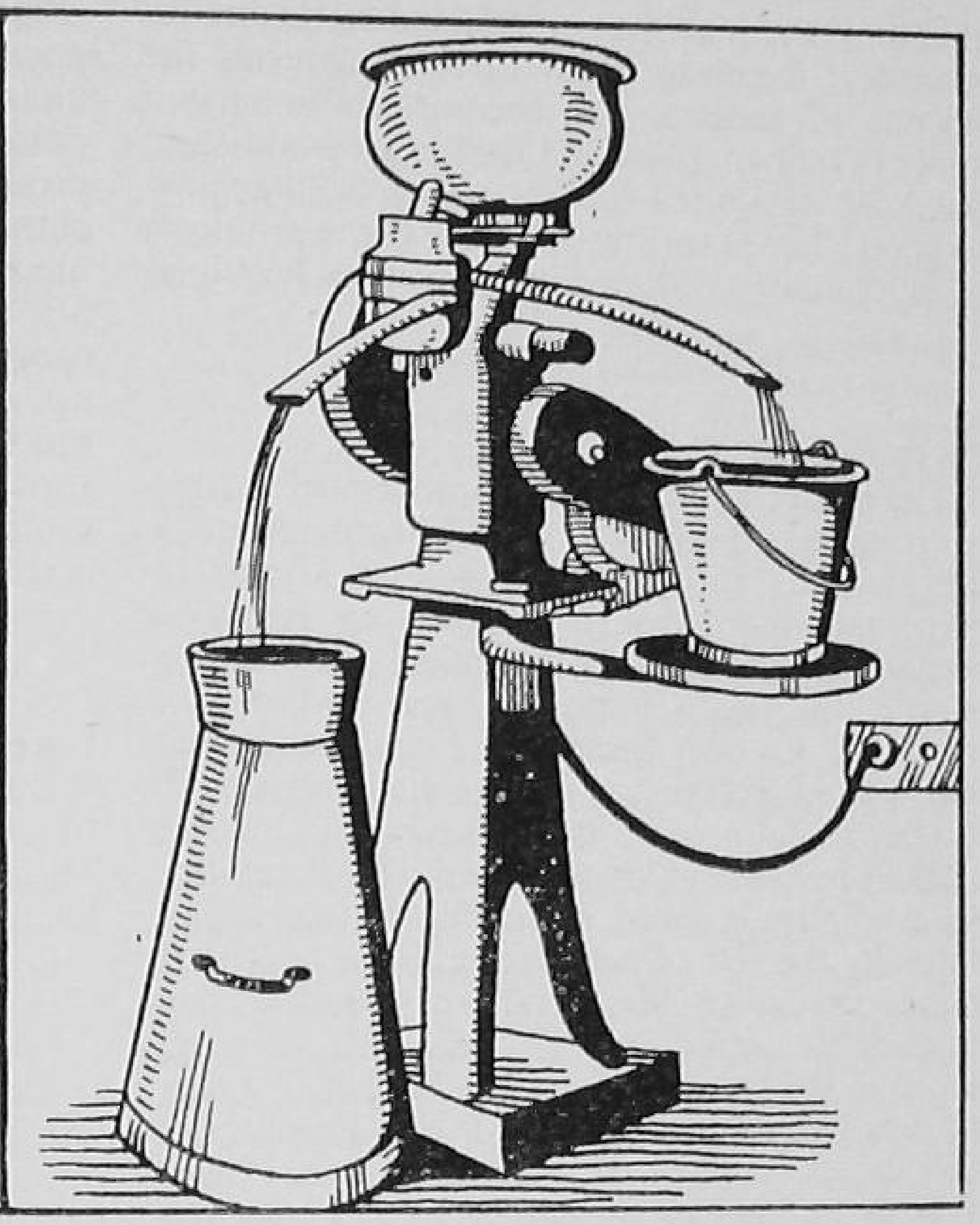
It is an old saying that the bull is half the herd. In point of fact he may be much more than this. There are at least three possibilities resulting from the use of a bull in a dairy herd:—

(*a*) Yields may be reduced.
(*b*) Yields may be maintained.
(*c*) Yields may be improved.

If the standard of milk-production is already good, it is important to maintain this level of production. Unfortunately there is always a measure of uncertainty as to the capacity of the bull to sire good yielding daughters. The element of uncertainty can be reduced by making use of animals whose immediate ancestors have satisfactory productive capacities. Cases are not unknown, however, where full brothers of good productive breeding have given widely different results, even in single-purpose dairying breeds. Experienced breeders rely increasingly on the method of proving bulls by their progeny, and then using such animals extensively. The next best thing is to buy, or breed, a young bull from a proven dairying family that in turn has been sired by a proven bull. It is an old lament in breeding practice that too many bulls have become famous after they have been sold to the butcher. The good breeder who values his stock is prepared to experiment in the proving of bulls, and to retain them until the productive qualities of their daughters are known.

The average farmer in search of a bull goes to a collective sale and apart from the price he studies only two factors. The first is the female pedigree, with such information that is contained in the catalogue as to the milk-records, particularly of the dam's family. The second is the bull himself, and often this is considered of greater importance than the family. No constructive breeder would be satisfied with such a selection. It is always wise to know the qualities of the dam and the sire's dam, for yields alone may be misleading. Good shaped udders for example wear better than ill-shaped pendulous udders, and these are points that can be transmitted by a sire. Furthermore it should not be overlooked that to





MILK BOTTLING AND SEPARATING.

go back four generations an animal has thirty different ancestors, if no in-breeding has been practised. Before buying a new bull I like to know the make-up and performance of all these ancestors at least for three generations back, which means extending the pedigree on both the sire's and dam's families.

Eliminating some of the Uncertainties.

With a view to eliminating some of the uncertainties, many breeders of dairy cattle practise a system of line-breeding which ensures a greater concentration of prepotent dairying ancestry when proven animals have been employed. In careful hands line-breeding or diluted in-breeding is responsible for the successful concentration of high-milk yielding properties and moreover ensures that certain type features are more quickly fixed in a herd. Most of our pure-breeds in the early days of their development were influenced beneficially by the practice of close-matings such as father to daughter, son to dam, brother to sister. Close matings of this kind are not generally favoured by modern breeders, but the mating of half-brother and sister, or cousins or relationships still more distant is widely followed by skilled breeders. Probably one of the most satisfactory methods of line-breeding is to carry on the blood of a prepotent sire that has already been used successfully in a herd, through a son, out of a high-yielding cow that is unrelated to the rest of the herd.

Uniformity in Type.

Breeding or mating merely on the basis of records is not by itself going to attain that complete improvement in the efficiency of live-stock which is desired. The ideals of breed type have not been hastily drawn up, and though some are prepared to argue that it matters very little what an animal looks like as long as it serves its purpose, that is not the accepted view of "stock-proud" breeders. There is just as much an art in knowing how to mate animals as there is in spotting a winner before training has commenced. The attainment of uniformity in type takes time and much sorting and sifting is necessary before this is achieved. Intelligence, common-sense and good judgment must be used not only in buying a bull, but also in mating him with particular animals in a herd. One of the shortcomings of artificial insemination is that it is not possible for one bull to satisfy all the different types of cows that occur in a large number of herds.

THE INFLUENCE OF FEMALE STOCK.

Capacity of the Cow.

The dairy cow is the most efficient of all animals as a converter of farm food-stuffs into human

food, but the differences between cows are considerable when judged from the angle of profitability. To the milk-producer, the first concern is that the cow should yield milk in sufficient quantity at the time of year when it is most needed. This involves two main factors, the capacity of the cow to fulfil what is required of her and the management given by the farmer or his cowman. Good management is always a primary requisite in any herd and it is difficult sometimes to divorce the effects of good management from those of good breeding.

If the bull is regarded as being at least half the herd, the cow shapes the destiny of her own progeny. To assume that the bull is entirely responsible for progressive improvements is only likely to delay the realization of constructive developments. A good bull deserves good cows and this requires an understanding of the constitution of a good cow. The productive dairy cow is a hard-worked animal and for this reason her frame should be equal in all respects to standing up to the strain imposed on her. This means in effect that in addition to correct conformation, milch cows should be properly reared from calfhood, so that well-grown and strongly constitutioned animals result. Experience shows that the best-grown animals within a breed are the best milk-producers and this is a point to observe in herd management.

The Long View.

The foundation stock of most commercial milk-producing herds is bought in the open market without any indication of its commercial properties beyond those that are obvious to the eyes of the purchaser. Most beginners have limited capital resources, which usually means buying the numbers required to stock a farm, as distinct from buying individuals of worth-while value. The virtue of the dairy cow is that she yields an income as soon as she calves down and as most cattle are of the so-called dual-purpose type in this country they are fed off for the butcher when unsatisfactory as milkers. Taking the long view, it is much sounder to start in a small way with a healthy herd of proved milk-yielding capacities and this is especially the case where a breeding policy is to be pursued. The type of animal envisaged is usually the product of a milk-recorded herd. As we are living in days of progress, it may be assumed that the present efforts to stimulate the practice of milk-recording, pedigree breeding and the cleaning up of herds in respect of disease will in the future make easier the lot of the dairy farmer in selecting better foundation stock.

In order to protect his capital, it is important that the beginner should make the fewest mistakes possible. There are not enough good pedigree milk-recorded cattle to supply every need and the really good ones are generally out of the reach of the ordinary beginner. Since pedigree has no particular virtue unless it is identified with proved commercial properties, one is advised to avoid buying pedigree cattle merely because they are registered. It is far more satisfactory to buy good non-pedigree animals and to grade these up to pedigree status by the use of good pedigree bulls. Opportunities will be provided in the course of a farming lifetime to buy pedigree animals if one really gets interested in high-class breeding. After a few years of experience one is generally in a position to make a success with good purchases made from the herds of good breeders. Bargains are often picked up in this way and the ordinary milk-producing farmer can rarely afford to buy female stock at such extravagant prices as often rule in fashionable pedigree circles.

Reliable Cattle.

A further important point is to buy foundation females that are not the unwanted drafts from other peoples' herds. In many milk-producing areas the integrity of cows offered in local markets is often in question. The ideal is to buy cattle from a good breeder's herd that is being dispersed, as distinct from the sales of cattle that are the culls of existing herds. There are some breeding districts where the cows are drafted on a regular basis after producing their third or fourth calf. These are likely to be reliable cattle, though one can buy-in abortion, mastitis and other troubles and unsound judgment is often revealed in the subsequent milking performance. The purchase of un-mated heifers is the shortest cut to reducing the risk of importing disease, but most people find it easier to assess dairying propensities in a newly-calved cow, and it has to be borne in mind that cows in milk provide an immediate income.

The selection of foundation stock is only the beginning, for ideals must be formulated regarding the subsequent breeding policy. In milk-producing herds one can never judge the value of a bull except through his progeny, but before this is possible many of the original foundation cows will have proved unworthy on grounds of unsatisfactory yields, breeding troubles and disease. In my own experience it has taken at least fifteen years of milk-recording, and severe culling to raise a worth-while herd. The most surprising feature here is the comparatively small number of families in the herd that have survived the testing period, and this despite the use of prepotent bulls. Thus out of the original fifty Dairy Shorthorn breeding cows I bought for the Midland Agricultural College herd in 1929-30, only ten families remain. This experience has emphasized the strain factor in the female line, independently of the bulls employed in the herd. This after all is some excuse for the creation of fashionable lines of breeding, when such fashion is linked with a family prepotency to reproduce good commercial animals.

BRITISH BREEDS OF DAIRY CATTLE

In this Section the breeds are classified in accordance with the division into Dual-purpose and Single-purpose types as shewn in the first paragraph below. There follows a concise account of each breed.

CATTLE are classified on a basis of dual-purpose or single-purpose qualities:—

Dual-purpose types	*Single-purpose types*
Dairy Shorthorn	British Friesian
Lincoln Red Shorthorn	Ayrshire
Red Poll	Guernsey
South Devon	Jersey
Welsh Black	Kerry
Dexter	
Blue Albion	

The Dual-Purpose Ideal.

The dual-purpose types have the reputed capacity for combining good beefing properties with satisfactory dairying qualities in the same animal. Opinions differ as to the relative efficiency of breeds in this respect, but in practice there is no sound reason why the dual-purpose ideal should not be attained if care is exercised in the selection of breeding stock. The dual-purpose types are the most widely distributed of all in this country. Such cattle are expected to give an average yield varying from 600 to 800 gallons per year, to have the capacity to fatten readily when dry and to produce bull calves that when steered make good beef carcases. Any heifer that fails to breed or has to be drafted can similarly make good beef. Provided a breeder knows what he is aiming for in this type of cattle, the dual-purpose ideal fits in very well indeed with English cattle breeding requirements because here a good market will always obtain for suitable feeding animals in grazing districts. The chief criticisms of this type in the past have been with regard to the uncertain nature of milking properties (which can be corrected by good breeding), and the fact that the milk-production of a dual-purpose cow is not sufficiently high for the small intensive farm. This latter is the more valid criticism, for the specially developed dairy cow of high-yielding capacities earns much more income as a milk-producer over a number of years than a haphazardly-bred dual-purpose cow with all her beef progeny. It is becoming difficult in a breed like the British Friesian to distinguish where dairy properties end and dual-purpose qualities begin. The breed in Holland is more dual-purpose in type than in this country, but since the 1936 importation many home-breeders have concentrated on breeding dual-purpose Friesians without any serious sacrifice of milk-yielding capacities.

The correct conception of dual-purpose type and ideals for this country is proven milking capacities first and beef second, rather than the development of a beef animal with problematical milking qualities.

Shorthorns.

The Dairy Shorthorn Breed. The original Shorthorns were natives of the Teeswater and Holderness districts in the north-east of England. These cattle were famous as dual-purpose types and improvements were made by Dutch bulls imported during the 17th and 18th centuries. The breed was fortunate in being developed by breeders of distinction in Charles and Robert Colling, whose herd was dispersed in 1810 and Thomas Bates of Kirklevington, who developed many well-known tribes which are still popular today. Bates's famous families were Wild Eyes, Duchess, Oxford and Foggathorpe and he paid special attention to dairy properties. This herd was dispersed in 1850. There were other breeders who developed fleshing and beefing properties, the most distinguished being the Booth family at Studley, Worlaby and Killerby, and Amos Cruickshank, of Sittyton, in Aberdeenshire. The Shorthorn is the oldest registered breed of cattle, a herd book having been started in 1822 by George Coates. Cattle from many foundations have been graded up into Shorthorn type and the virility of the breed owes much to the fact that grading-up to pedigree status is still possible.

The distinguishing type features are the colour which may be red, white or roan, of varying degrees, with red and white. The reds and whites breed true, but the roan behaves as a heterozygous Mendelian character, and so cannot be fixed. The nose is flesh-coloured, and the horns are short and reasonably fine and free from black at the tips. The average live weight of the mature cow is about 1,250 lb., but south country cows tend to be more rangy in form than north country Shorthorns. The average milk-yield is about 750 gallons with 3·7 to 3·8 per cent. of butter fat.

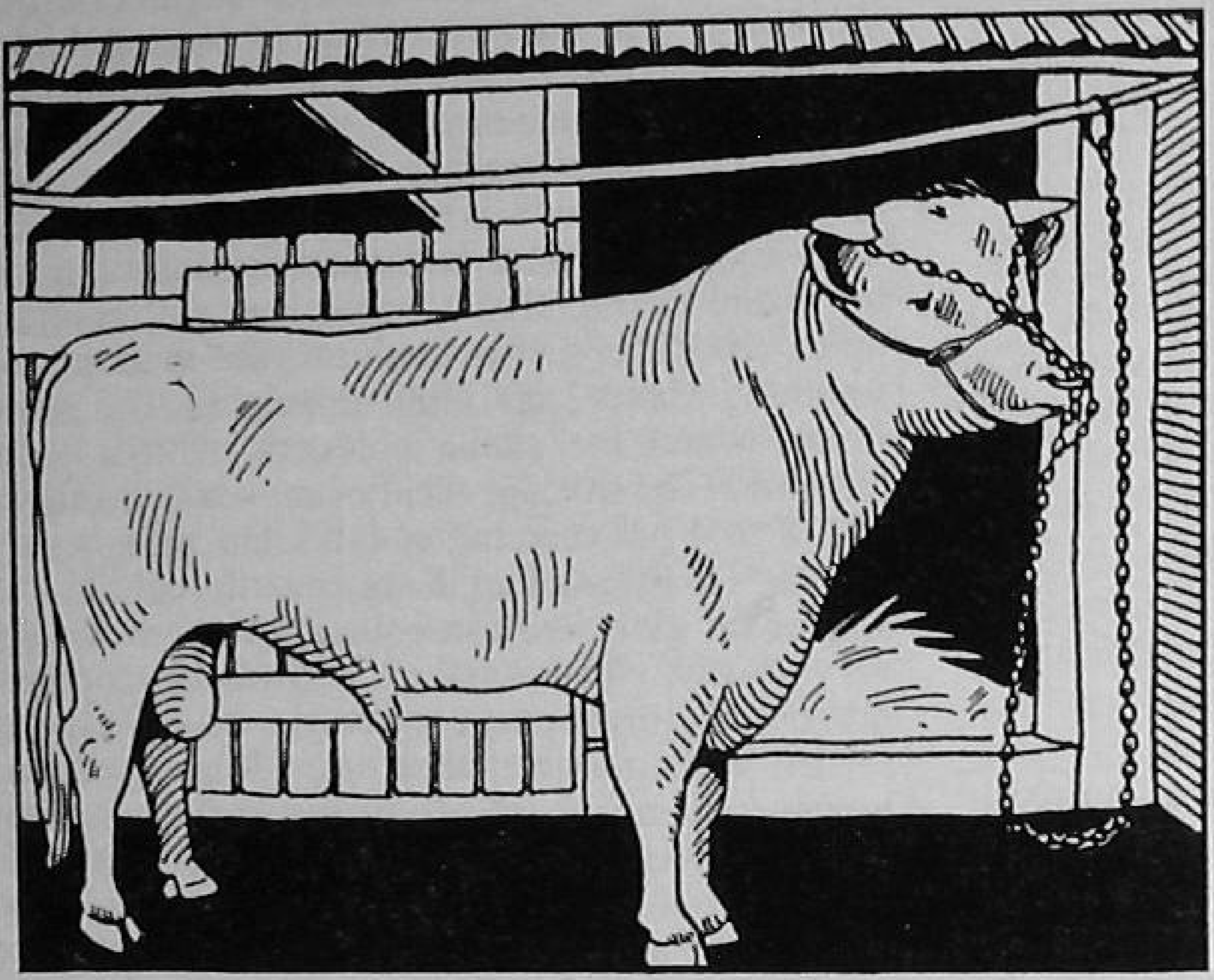
The breed is the most widely distributed of all types in this country and adapts itself readily to a wide range of soil and climate, though it gives the best results on good pastures. It has been the stand-by of the milk-and-feed type of milk-producer, typical of town dairying and producer-retailer systems.

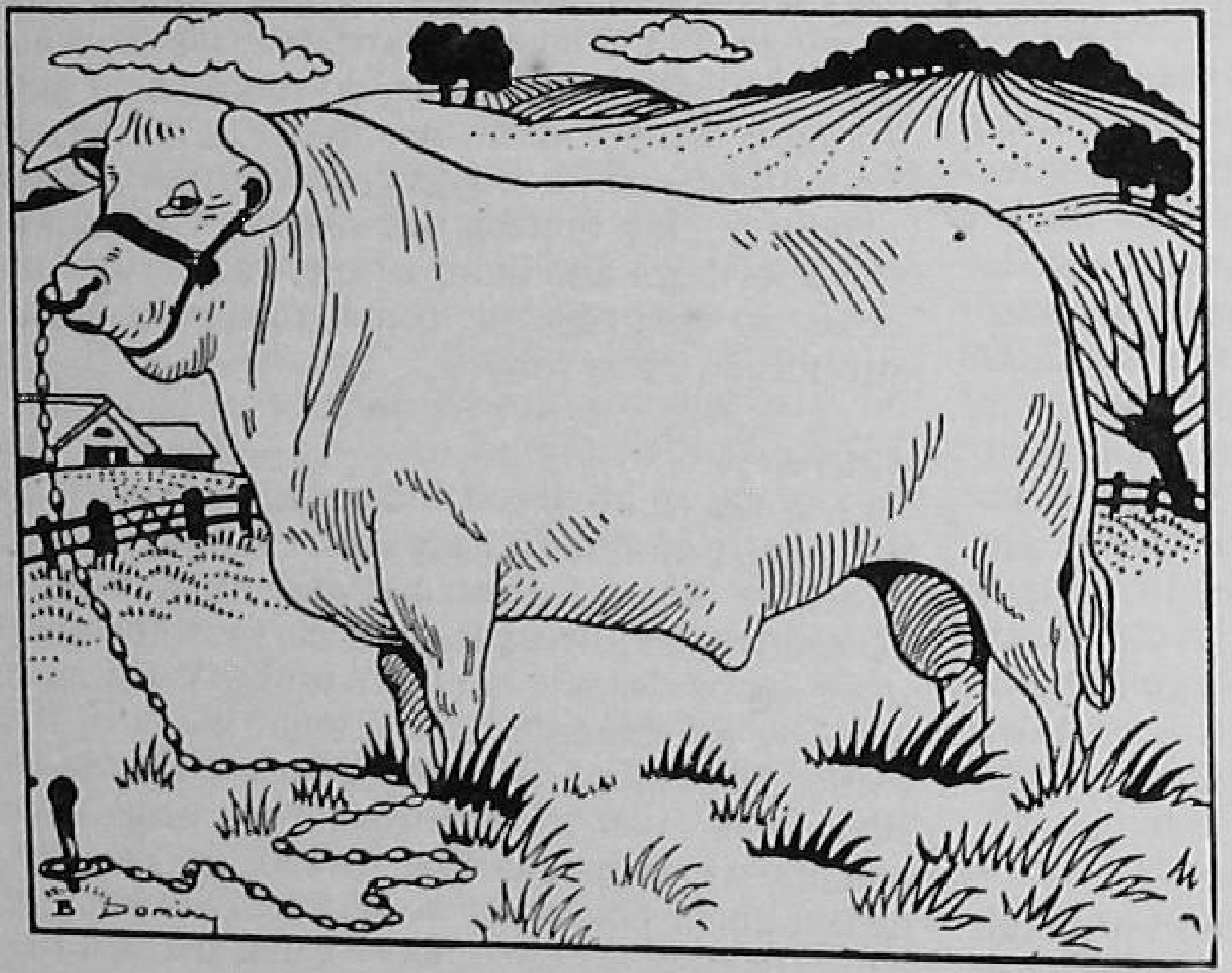
The Lincoln Red Shorthorn Breed. This is a variety of the parent Shorthorn type, originally selected for a deep red colour by Thomas Turnell, of Wragby, in Lincolnshire, and with a separate herd book organization. These cattle are slightly larger than Dairy Shorthorns, with a greater tendency to beef type. The breed is chiefly confined to its native county and the East Midlands.

Uniform since 1846.

The Red Poll Breed. Two East Anglian local breeds, the Red Norfolk Horned and the Dun-coloured Polled Suffolk were inter-crossed in the early part of the 19th century to give the present

type which has been more or less uniform since 1846 and with a herd book since 1874. The distinguishing type features are a blood-red colour, flesh-coloured nose, prominent poll with no horn scars, and an average live weight of 1,100 lb. for mature cows. The yielding properties are similar to Shorthorns, with 3·8 to 4·0 per cent





BULL TETHERS.

of butter fat. This is an ideal type of dual-purpose animal, possessing good foraging properties and good powers of converting home-grown produce. They do well on second-class pastures and their beef is of excellent quality. The breed is confined chiefly to East Anglia but also has an influential following in many other parts of the country.

One of Our Oldest Races.

The South Devon Breed. This is descended from a local type, the old South Ham Breed, which probably contained some Channel Island blood, especially from the fact that the milk is rich in butter fat and colour. The South Devon undoubtedly descends from foundations similar to those of the North Devon, and as such is one of our oldest races, probably linked with the Sussex and Hereford. Its distinguishing type features are a yellow-red colour, flesh-coloured nose, moderately long horns tipped with black, and very large in size, the average live weight of the mature cow being 1,450 lb. As yielders of milk these animals give about 600 gallons of 4·2 per cent butter fat, but much progress has been made in developing the dairying qualities in recent years. The milk is very suitable for butter and cream production, for the latter being extensively used in the Devonshire cream trade. The breed is confined chiefly to South Devon and parts of Cornwall. It succeeds best in mild districts and on very good land, which its native environment provides, while it produces very good beef.

For Exposed Situations.

The Welsh Black Breed. This has evolved from several types of cattle native to Wales, but chiefly the North Wales or Anglesey breed and the South Wales, or Pembroke or Castle Martin breed. The distinguishing type features are black colour, dark nose, horns of medium length, white at the base with black tips. The size is medium, the average weight of the mature cow being 1,150 lb. The dairying properties are being developed, the average yield being 550 gallons of 4·0 per cent butter fat. These cattle are confined principally to Wales, though steers find their way to Midland pastures for grazing. The breed is very suitable for exposed situations and second class pasture, and it has a good reputation for hardiness.

The Dexter.

The Dexter Breed. This is thought to be an off-shoot of the Kerry and originated in Ireland, probably with a Shorthorn infusion. It is recognized by a whole black or whole red colour, with horns that are rather long and heavy for the

size of body, and black tipped. The average live weight of the mature cow is only 650 lb., so that the breed is the smallest of the cattle family. The dairying qualities are very satisfactory in proportion to their size, the average yield being 450 gallons of 4·0 per cent butter fat. The distribution is very limited, and it is more of a smallholder's or family cow than a commercial dairy farmer's animal. The Dexter is not always easy to breed true to type and has a tendency to produce monstrosities in calves.

Conforms to Shorthorn Type.

The Blue Albion Breed. Although this is a registered type it originated by selecting blue coloured animals that were chiefly descended from Shorthorn-Friesian and Shorthorn crosses with other black cattle. In general it conforms to Shorthorn type with a blue-roan colour. This colour does not breed true, for which reason it must always suffer as a pedigree type. Nevertheless the breed is very handsome in appearance.

Distinguishing Features.

The British Friesian Breed. This is native to the district of Friesland in the north of Holland and has been imported into this country. Since 1914 importations have been confined to specially selected stock and the 1936 importation has had far-reaching consequences for the good of the breed in this country. The distinguishing features are the colour, comprising clearly defined patches of black and white with white below the knees and hocks. The horns are short and the body size is the largest of the purely dairy types, the mature cow averaging between 1,250 and 1,300 lb. live weight. The dairying qualities have earned, for members of the breed, pride of place as the most abundant milk-producers. There are more 2,000 and 3,000 gallon cows in this breed than in all others combined. Under commercial dairying conditions the average yield is 900 gallons per cow per year with 3·4 per cent of butter fat. Improvements have been made in the fat content and, in selected herds, 4·0 per cent averages are not unknown. The milk is pale in colour and the fat globules are very small, and this makes it suitable for infant feeding.

Best on Good Pastures.

The Friesian has made great progress in all milk-producing areas. The breed does best on good pastures and also responds well to soiling crops. Many of the modern cattle of this breed are typically dual-purpose, and their beef commands a high price by reason of the cleanness of flesh, that is the good proportion of lean and freedom from patchy fat. Bulls of the breed are being extensively used for crossing on Shorthorn herds with the object of increasing milk-yielding capacities. Friesian calves are very large at birth and meet a good market for veal.

A Good Forager.

The Ayrshire Breed. This is native to Ayrshire in the south-west of Scotland, but it is probably of mixed ancestry with Shorthorn, Dutch, West Highland, and Channel Island blood in its make-up. The pioneer improver was John Dunlop, at the beginning of the 19th century and its present type has been standardized for the greater part of a century. The colour consists of varying shades of red or brown, with white in well-defined patches. Black and white and brindle sometimes occur, but these are not in favour. The most popular colour is a white background with red markings. The nose is preferably dark and the horns are characteristic, being long and pointing upwards. The size is medium, the mature cow weighing about 1,000 lb. live weight. The breed is renowned for shapely udders, with a long, flat sole. The average yield of milk is 750 gallons of 3·8 to 4 per cent butter fat. The milk is very similar to Friesian milk as regards colour and size of fat globules, consequently the cream rises very slowly. The Ayrshire is probably the best all-round single-purpose dairy breed having regard to economic production. It has no claims however to any beef producing virtues, so that it is not a satisfactory proposition to rear male calves not required for breeding purposes. The breed is extensively kept in the south-west of Scotland, the district being notable for the large number of Attested herds. The availability of this large reserve of tuberculin-tested cattle has popularized the breed in England where it is now widely distributed. The Ayrshire is a good forager, adapts itself readily to a variety of conditions and is very dependable as a milk-producer. The breed is occasionally crossed with the Shorthorn and many of the very pretty show cows so popular in commercial classes are produced in this way.

Guernsey.

The Guernsey Breed. This is native to the Channel Islands of Guernsey and Alderney and probably descended originally from the cattle of Normandy and Brittany. The purity of the breed in its native islands has been safeguarded since 1779 by an embargo on the importation of live cattle. The colour of the breed consists of various shades of fawn or yellowish red, with white patches which are located usually on the face, flanks, under portion of body, legs and switch of tail. The nose is flesh-coloured, and the skin has a very yellow secretion, breeders paying special attention to this. The horns are medium to small in size, refined and of amber colour. The average live weight of the mature cow is about 950 lb. The breed is very early in maturing, heifers calving down at just over 2 years of age. The average yields in commercial herds is about 650 gallons of 5·0 per cent butter fat. The milk is very high in colour and butter made from Guernsey cream is the deepest coloured of all butters. The fat

globules are large and rise readily and this fact, together with the colour and richness of the milk, often leads Friesian breeders to keep a few Guernsey cows, where milk has to be sold in bottles, as the appearance and quality of such milk is improved. The Guernsey has the capacity for consistent production, but, like the Ayrshire, it has no claims to any beef-producing merits. The distribution is extensive, especially throughout the South of England. The animals prefer good land, where they do not have to work too hard for their living, but quite contrary to public opinion they are not delicate cattle.

Jersey.

The Jersey Breed. This is native to the island of Jersey; in common with the Guernsey, the purity has been safe-guarded since 1779 by the law prohibiting the importation of live cattle and this has ensured great uniformity in type and performance. The colour covers various shades of fawn, squirrel grey, mouse and dark brown. White is occasionally mixed with these colours, but is not popular. The nose is usually black or dark coloured and the muzzle is surrounded by a mealy-coloured growth of hair. The tail often has a black switch, while the skin has a deep yellow secretion as in the Guernsey. The horns are small and usually curved slightly inwards and black-tipped, while the head is shorter than in the Guernsey. This is one of the smallest of the dairy breeds, the live weight of mature cows being 800 lb. The animals are very fine in the bone, being almost deer-like in appearance. The Jersey is the quickest maturing of all breeds, heifers calving down at 2 years old or even earlier and thus they come into production from 6 to 12 months sooner than those of some of the larger breeds. The average yield is about 600 gallons of 5·3 per cent butter fat, this being the richest of all milks. The qualities of the milk are similar to that of the Guernsey, being most suitable for cream and butter-making, and also suitable for improving the colour of Friesian and Ayrshire milks. The breed is widely distributed, but prefers favoured conditions and good pasture. Like those of most small breeds the animals are economical cattle to feed, the females being docile to handle; but they have never become popular with the general commercial farmer from the fact that their refined features give an impression of lack of constitution, which is not necessarily true. As in the case of Guernseys, they have no pretensions to any beefing qualities, the flesh being poor and the fat very yellow.

Kerry.

The Kerry Breed. Originating in Kerry and the hill districts of the West of Ireland, this was once known as the "poor man's cow." Black in colour with fine white horns and small in size with the mature cow averaging 850 lb. live weight the breed is not of considerable significance in milk-producing spheres in this country. It is a very active and hardy type, thriving well under poor conditions, with an average yield of 550 gallons of 4·0 per cent butter fat. Like all small breeds, however, it is a very economic producer.

THE SELECTION OF A BREED

The principles upon which the dairy-farmer should proceed are set out in some detail.

THE beginner in dairy farming should pay careful attention to the selection of a breed that will conform to his requirements. The actual choice should take into account the various factors that have a bearing upon the system to be followed. A safety measure is to select the type which predominates in the district, since it can be assumed that the popularity of this type has been maintained on economic grounds. Apart from this the trade for surplus stock is likely to be good if a popular breed is chosen The existence of local breeds in certain districts should be noted, but to take purely localized types to other areas remote from the home of the breed will necessitate journeys to obtain replenishment of stock or even to find a profitable market for surplus animals.

The climate, soil and level of fertility often determine the area covered by local breeds. For poor grazing and high-lying pastures choose hardy, active types, whereas for lower-lying and more luxurious pastures the larger and less active types may be selected. It is a wise precaution in the selection of individual animals to buy cattle from poorer conditions than those for which they are required. Cattle brought up in the lap of luxury cannot be expected to do as well if they are taken to poorer conditions.

The Chief Breeds.

Attention should also be paid to the purposes for which the milk is required, whether for milk-selling, cheese-making, butter-making or general purposes. The chief breeds for milk-selling purposes are Dairy Shorthorns. British Friesians, Ayrshires, Red Polls and Lincoln Reds. The milk from Friesians and Ayrshires by virtue of small fat globules is very satisfactory for sending away by rail, owing to the absence of churning. For cheese-making requirements one should remember that quality in addition to quantity is important and the special favourites are Dairy Shorthorns and Ayrshires, but all the types under the milk-selling group are suitable. In cream and butter-making requirements, the preference should be given to Guernseys, Jerseys, and South Devons. Where a high class producer-retailer bottled-milk trade has to be supplied and a good cream-line on the milk assumes importance, herds of both Friesians and Ayrshires are improved by an admixture with Guernseys or Jerseys. Breeds which are specially suitable for exposed climates are Welsh and Kerrys.

Dual-Purpose or Single-Purpose.

The economic value of the breed is also important. This can be argued from two aspects, and raises at once the question of a dual-purpose or single-purpose ideal. It can be said quite definitely that the dual-purpose ideal is only sound from a milk-producing standpoint if the major emphasis is placed on the capacity of the cows to yield adequate and certain yields of milk. Provided this is assured then the capacity to make satisfactory beef when dry or to produce calves that make good veal or grow into good steers is not without significance under average farming conditions in this country. This is a point which is likely to assume significance in the years just ahead of us, though for a small farmer anxious to make the maximum income out of milk alone, concentration on high-yielding single-purpose types seems to be indicated.

Most of those who go in for milk-production seriously will already possess adequate practical experience of different breeds and in consequence certain preferences will have been formed. This is a very important factor, for when one has a special interest in a particular breed, success can be achieved irrespective of other factors. To make a hobby as well as a living out of a breed is the secret of the success of many breeders and to have this enthusiasm for a breed is the first step towards achieving fame as a breeder. There is however no perfect breed, nor even a best breed. All breeds have good strains and bad strains and the true object of the constructive breeder is to know the strains and families and select and perpetuate those that are worth while. Thus the Friesian is satisfactory as a yielder of milk, but many families produce poor quality milk. Good Friesian breeders, however, have concentrated on the elimination of low butter-fat strains and in consequence have effected great improvements. This is an important point to watch, for cattle that give poor quality milk are a nightmare to the milk-producer especially as the legal presumptive minimum is that milk should contain 3·0 per cent of butter fat and 8·5 per cent of solids not fat.

INDIVIDUAL SELECTION OF DAIRY CATTLE

In this practical Section there is again a discussion of principles. Attention is drawn to the importance of taking into account the vital features or characteristics of the ideal animal. Pointers to be considered in selection of the individual animal are given under three heads: Dairy Type, Capacity for feeding and living *and* Udder Development. *There follows a discussion of* General Points in Relation to Type. *The Judging of Dairy Cows is explained with an account of the way in which a score-card may be used. The final section of this section deals with the individual selection of dairy bulls.*

THE SIGNIFICANCE OF TYPE.

Judging Animals.

THE progress of livestock improvement is commonly assessed in the show-ring by judging animals on inspection. Breed societies have drawn up scales of points which serve to emphasize the qualities associated with animals that conform to the ideals of good judges. Breed societies in turn maintain a desirable standard of judging by nominating panels of judges who are considered to be conversant with the requirements of their own breed. No serious breeder of dairy cattle is prepared to base a breeding policy on the winners of inspection classes, unless such animals also possess productive qualities of high merit. Since milking-records are available for a small proportion only of the commercial cattle offered for sale, buyers are required to exercise their judgment in the selection of stock, and it is fortunate that there are some external aids which are of help in choosing productive dairy cattle.

Judging is an art as well as a science, but there are no mysteries that cannot be defined and one of the most satisfactory developments of recent years has been the encouragement of instruction in livestock judging in connection with the activities of agricultural colleges, farm institutes and Young Farmers' Clubs. In most cases such training is based on the use of a score-card, which is designed to concentrate attention on the vital characteristics or features of an ideal animal. By constant practice it becomes possible to assess the virtues of an animal independently of the score card. The successful stockman is able to weigh up the qualities of an animal very quickly and to give adequate reasons for his judgment.

In pure-breeding spheres the purely commercial virtues of an animal are occasionally discredited by the operation of fashion crazes in regard to certain features. It is often presumed, for example, that one colour is better than another and this is true of most breeds. In the red-coloured breeds, the deep shades are the most popular, though there are suggestions that the yellow shades are identified with richer coloured milk. In some of the Midland counties, white-coloured Shorthorns are worth less than other colours, and roan, which will not breed true, is favoured. It is obvious however, that when pride is taken in conforming to breed type, features of an undesirable type should not be perpetuated, no matter how good an animal may be in other respects. Thus the colour of the nose, the shape, size and colour of the horns may be of little importance to a commercial breeder, but they often assume significance in the breeding of pedigree cattle.

There are three main features which may be said to be correlated with good yielding capacities, though as pointed out previously these are not an accurate guide to actual milking capacities. At the best they are only pointers.

Typical Dairy Cow.

1. *Dairy Type*. A typical dairy cow is said to be wedge-shaped in three directions. Viewed from the side, there is the greatest depth of body towards the hindquarters. Viewed in front, the body widens from the forequarters backwards to the hips and hindquarters. Viewed from above at the withers which are fine or sharp, there is a broadening to the shoulders. In the single-purpose types great stress is placed on fine withers, though this is not so marked a feature in the dual-purpose breeds. The relatively light forequarters are in marked contrast to the beef type, where the conformation is more even and blocky. It is argued by the breeders of single-purpose dairy cattle that dairy conformation is evidence of the capacity of the cow to convert her food intake into milk rather than into flesh and that a reproduction of beef form in a dairy beast reduces her efficiency from the standpoint of milk-production. The significance of great width in the hindquarters across the hips and extended to the pin bones is to allow capacity for carrying a large udder with well-spaced hind legs. This breadth in the hindquarters is not necessarily peculiar to high-yielding dairy cattle. It is perhaps emphasized to the greatest degree in Friesians that have resulted from the strains introduced in the 1936 importation from Holland. Some judges attach significance to good length in the quarters from the hooks to the pin bones as providing space for an udder with length from front to back. Associated with this wedge conformation, there should be a straight top-line and the head and neck should be sufficiently refined to balance the rest of the frame. When horns are present these, likewise, should be light and refined.

2. *Capacity for feeding and living*. The good milk-producing cow must be a heavy consumer of food and possess the ability to withstand the strain which high milk production imposes. A large wide barrel is generally indicative of good consuming capacity. By contrast flat, short-ribbed

animals tend to be weak in constitution and poor feeders.

Udder Type.

3. *Udder development.* Good dairy cows possess large and well-shaped udders, with even quarters and particularly well-developed hind-quarters that come well out behind and extend high up at the back. One should discriminate against udders that are fleshy, ill-shaped and pendulous. Good judges pay great attention to udder type not only from a standpoint of symmetry but also from the angle of milking life. Cows with udders of the dropped, swaying type, are more liable to udder injuries. A good cow retains " hold " of her udder even in advancing years and desirable udder wearing properties can be cultivated by careful selection and breeding.

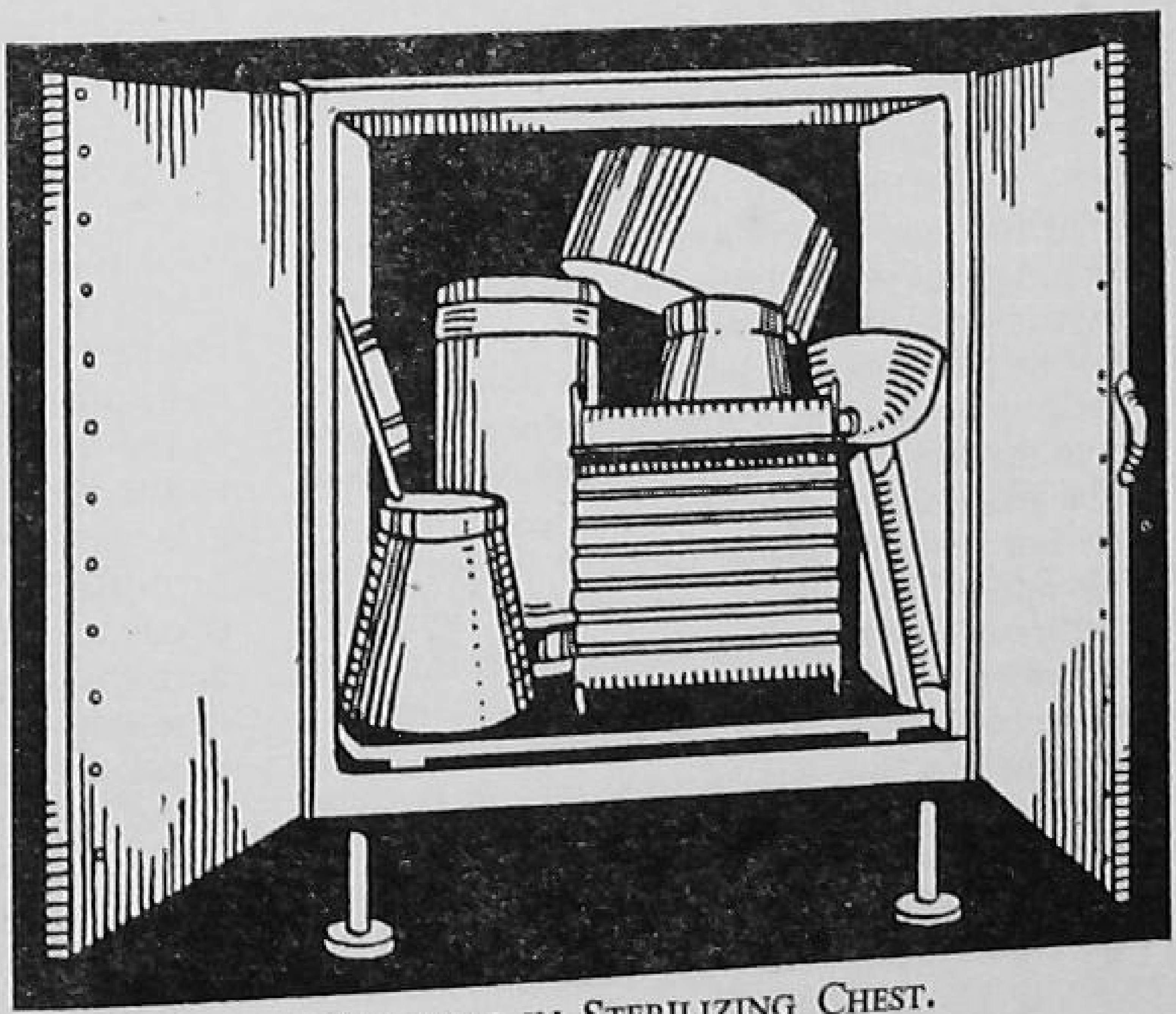
The teats should be reasonably well spaced, of a convenient size and the milk should draw easily. Hard milkers are an abomination, but equally the teats should not be so easily drawn that the cow has difficulty in storing milk. The shape of teats varies and rough or very small teats are both objectionable. Flat ended teats are apt to lose milk by running and should be avoided.

The milk veins should be large, prominent and branched, extending well forward from the udder and, where they enter the wall of the abdomen, the openings or " wells " should be large. Good milk veins in a mature cow are a reliable index of milking capacity, though it must not be assumed that they conduct milk to the udder. Their purpose is the conveyance of blood from the udder to the heart. They are more marked in some breeds than others and are specially prominent in Friesians.

" Stocking the Udder."

In the purchase of cows without known yielding properties there is greater risk in the buying of a down-calving (in-calf) or dry cow than one that has freshly calved. In the former case, the udder may not fill up as shapely as is desirable, while there may be defects in quarters or teats that only become obvious when the cow comes into milk. At the same time one should avoid the animal that is being sold with an over-stocked udder after calving. " Stocking the udder " is the practice of leaving a newly calved cow unmilked for an unusual length of time prior to sale. This causes an undue distension of the udder, and while it is actually a deceitful practice, it is also cruel to the cow and liable to bring the practising party within the provisions of the Cruelty to Animals Acts; furthermore it is detrimental to the cow's milking capacities in the following lactation. It is important to handle the udder after the cow has been milked-out after purchase, to see whether any indurations or lumps are located in the quarters, as these tend to indicate disease. Allowance must, however, be made for the udder which is inflamed and hard, called " hogged," a condition sometimes associated

Drawing off the Fore-milk



Dairy Utensils in Sterilizing Chest.

with a newly calved cow, and one that is normally associated with good yielding animals.

General Points in Relation to Type.

The Type of Animal.

The ideal dairy cow is a quality animal and breeders' ideals are to some extent based on the type of animal that meets with a good demand in the commercial markets. In the dual-purpose breeds, where fleshing properties are often studied in association with dairying propensities, the quality of the fleshing receives close attention. The fleshing should be clean, as distinct from the tendency of some animals to store up patchy fat on the hooks, hindquarters and pinbones. Clean cut joints, knees and hocks are also important. Swellings on knees or hocks detract from the value of a cow and often suggest the effects of disease apart from injuries sustained in cowsheds in winter. Judges in the past have attached some importance to the handling qualities of the skin, especially over the ribs. Mellowness in skin touch is indicative of good health and is common to both dairy and beef types, while the condition of the hair is also a guide to good health. A coat which is wiry and stary sometimes suggests ill-health, but the hair of the dairy cow can be influenced favourably by grooming and management as in the case of a horse. In my own examination of good milk-producing animals I have failed to establish any correlation between a good skin touch and good milking properties, but by tradition one generally favours the animal that touches well and where the skin is loose and mellow. I have known dairy farmers attach importance to the type and length of tail, but this again is a quality point and judges favour a fine tail. Dairy character is also associated with a well-carried head and action that is active and vigorous, though from a management viewpoint the cow should be free from vicious habits and kicking and bullying in particular.

There is some evidence that the larger cows within a breed are the heaviest yielders of milk, but this must not be assumed to suggest that large animals are the most efficient producers. It is often contended that the smaller breeds are more efficient converters of food into milk than are the larger breeds. It is of importance that breeders are tending to discriminate against excessively large animals in most of the milk-producing breeds.

The Judging of Dairy Cows.

Score Cards.

Much attention has been given in recent years to the training of young people in judging live-stock. Those possessing good observation readily acquire the art of distinguishing the difference between good and bad animals. Score cards have been utilized extensively, and these serve a valuable purpose in concentrating attention on the more important details of animal conformation and productive capacities, as distinct from those points which result from fashion, fad or fancy. The object of training in livestock judging by means of score cards is to instil the habit of knowing what to look for so that this becomes almost second nature. The best score cards are of a simple character and as a means of striking uniformity in using them in practice I have found it simplest to classify defects on the following basis:—

(*a*) Perfect or ideal	full marks
(*b*) Slight defect	$\frac{3}{4}$ of total marks
(*c*) Medium defect or deficient	$\frac{1}{2}$ of total marks
(*d*) Marked defect or bad	$\frac{1}{4}$ of total marks

The following is a suggested score card for a dairy cow:

	Perfect Score
I. Dairy Type 36 points	
Form—wedge-shaped; straight top-line; legs straight and fine-boned; fine head and neck; light, clean brisket	24
Quality—fine silky hair; mellow and loose skin of medium thickness	8
Temperament—alert, yet quiet to handle	4
II. Capacity for Feeding and Living 28 points	
Chest—deep and broad between and behind fore-legs	8
Barrel—deep, long and large, with well sprung ribs and no sign of slackness at loin	16
Muzzle—broad, with strong jaws, and large mouth and nostrils	4
III. Mammary Development 36 points	
Size—large, but not fleshy, with ample thin silky skin, and free from lumps	12
Shape—fore-udder carried well forward; rear-udder well-rounded, attached as high at back as possible; quarters evenly balanced; floor of udder level (not cut up between teats); not pendulous	16
Teats—well-spaced, of convenient size, placed at right angles to udder, easy to milk and no distension at base	4
Milk Veins—large, prominent, extending well forward and branched; milk wells, large	4
Total	100

The Individual Selection of Dairy Bulls.

Amongst thoughtful breeders conformity to

show-ring type is secondary to the merits of the dam of a bull as a dairy cow and the prepotency of the sire in the dairying sense. It is an added virtue if the bull's dam has a good health and regular breeding record as well as a long milking life. There is the same need for studying conformational details as in the cow, though sex differences cause certain deviations in character. One should be able to see the outline of dairy type in the bull as in the cow, with a large, deep body and well-developed hindquarters. Some breeders emphasize the need for masculinity in features if a sire is to be impressive. Others prefer a refined head and stress the need for fine-quality horns. It is obviously sound that the character of head should be definitely masculine, and with milk-producing breeds vigour and vitality in the bull is usually associated with abundant courage and mettle.

The normal practice in commercial dairy herds is to buy a young bull at 12 to 15 months old, use him in the herd for three years, or until his first heifers are old enough to be mated, when he is sold off fat and replaced by another young bull. There are two evils resulting from this custom. The first is the tendency for prepotent dairy sires to be killed before their true merits are recognized. The second is that continuous changes of bulls tends to make more difficult the attainment of uniformity of type in a herd. Within recent years increased attention has been paid to the employment of progeny-tested sires, that is bulls whose female progeny have proved satisfactory as milking animals. The objections to the use of mature sires are three. The first concerns the fact that some old bulls get bad tempered. This is frequently the result of lack of exercise and isolation. The second is that old bulls are sometimes too heavy for mating with heifers. This can be overcome either by artificial insemination or by the use of breeding stocks to take the weight of the bull when serving a heifer. The third is that the average milk-producing herd is not big enough to justify the expense of keeping several sires and therefore the proving of bulls belongs to the sphere of the large specialist breeder.

The True Test.

The true test of a proven sire is his capacity for siring daughters that are superior to their dams as yielders of milk, based on quantity combined with quality. In the Shorthorn breed, bulls have been accepted hitherto for the Register of Merit if ten daughters qualify in yield for the standards required for bull-breeding cows. This by itself is worthless, for if a bull is used in a large herd, the chances are that even a moderate animal will get the required number of daughters to qualify. With the Improved Register of Merit, at least 50 per cent of a bull's daughters must have satisfied the yield qualifications. In the United States of America the Mount Hope Bull Index has become popular. This system adjusts the records of the dams and daughters so that they compare for age, length of lactation and frequency of milking. Correction tables have been worked out for all the factors concerned and the bull's milk index, where the daughter's yield is greater than the dam's, is reached by adding the difference to the daughter's average, and where the yield is less than the dam's, of subtracting the difference from the daughter's average.

LIVE-STOCK IMPROVEMENT

In the introduction of this subject three angles of view are set out:—(a) Productive capacities, (b) Looks or appearance and (c) freedom from disease.

Aids to Dairy Cattle Improvement are discussed in some detail. Particulars are given, under this general heading, of Bull Licensing, Premium Bulls, Artificial Insemination, Grading Up, The Agricultural Show, Breed Societies and Milk-Recording.

FARMERS are now being advised of the necessity for concentration on improving the standard and efficiency of livestock. The policy in question is being fostered by the Ministry of Agriculture through the County Agricultural Executive Committees, and is designed to interest the ordinary commercial farmer in the possibilities of improving his financial prospects in the years immediately ahead. It is not to be compared with land improvement in the rapidity with which results are likely to be realized, but it can be assumed with certainty that properly cultivated land producing crops and grass of better feeding value needs good stock to enable the farmer to realize the full returns he is entitled to expect.

There are three angles from which live-stock improvement can be viewed. The first concerns productive capacities; the second, looks or appearance; and the third freedom from disease. The breeder of beef animals can make progress more quickly than the breeder of dairy cattle, since the form of the animal is a guide to the actual meat-producing qualities. The breeder of dairy cattle has no such easy means of distinguishing productive qualities. There is only one acid test for the breeder of dairy cattle and that is the actual yields of the animal.

Looks or Appearance.

Concerning looks or appearance, I do not share the views of those who say that they do not matter. Our conceptions of beauty may differ, but we might as well be honest with ourselves and recognize that the art of breeding is a very poor thing if it cannot give us breeds of animals that do not offend our eyes. The importance of freedom from disease speaks for itself.

AIDS TO DAIRY CATTLE IMPROVEMENT.

The improvement of the standard and efficiency of livestock is related closely to the breeding policy pursued by the individual breeder. Various official schemes operate with the object of breeding better cattle.

BULL LICENSING.

A Licence.

Under the provisions of the Licensing of Bulls Act, 1931, all bulls reaching the age of ten months must be approved by a Live Stock Officer of the Ministry of Agriculture. Application for a licence should be addressed to the Secretary, Ministry of Agriculture, not later than 28 days before the bull is 10 months old, such application being accompanied by a fee of 5s. Bulls passed by the inspecting officer are tattooed in the right ear with a crown and a licence is issued. Bulls rejected by the inspector are marked in the left ear with a letter "R" and a notice is issued to the owner requiring the slaughter or castration of the animals in question within a specified time. Provision is made for an appeal, but these rarely succeed.

It is important that rearers of young bulls should make it their business to keep only those calves out of good cows, and to rear them well. Bulls with only one testicle down are usually rejected.

Since 1945 a Dairy Bull licence has been available for animals whose sire and dam have any one of the following minimum yields:—1st lactation, 600 gallons; 2nd lactation, 700 gallons; 3rd and subsequent lactations, 800 gallons, in 365 days.

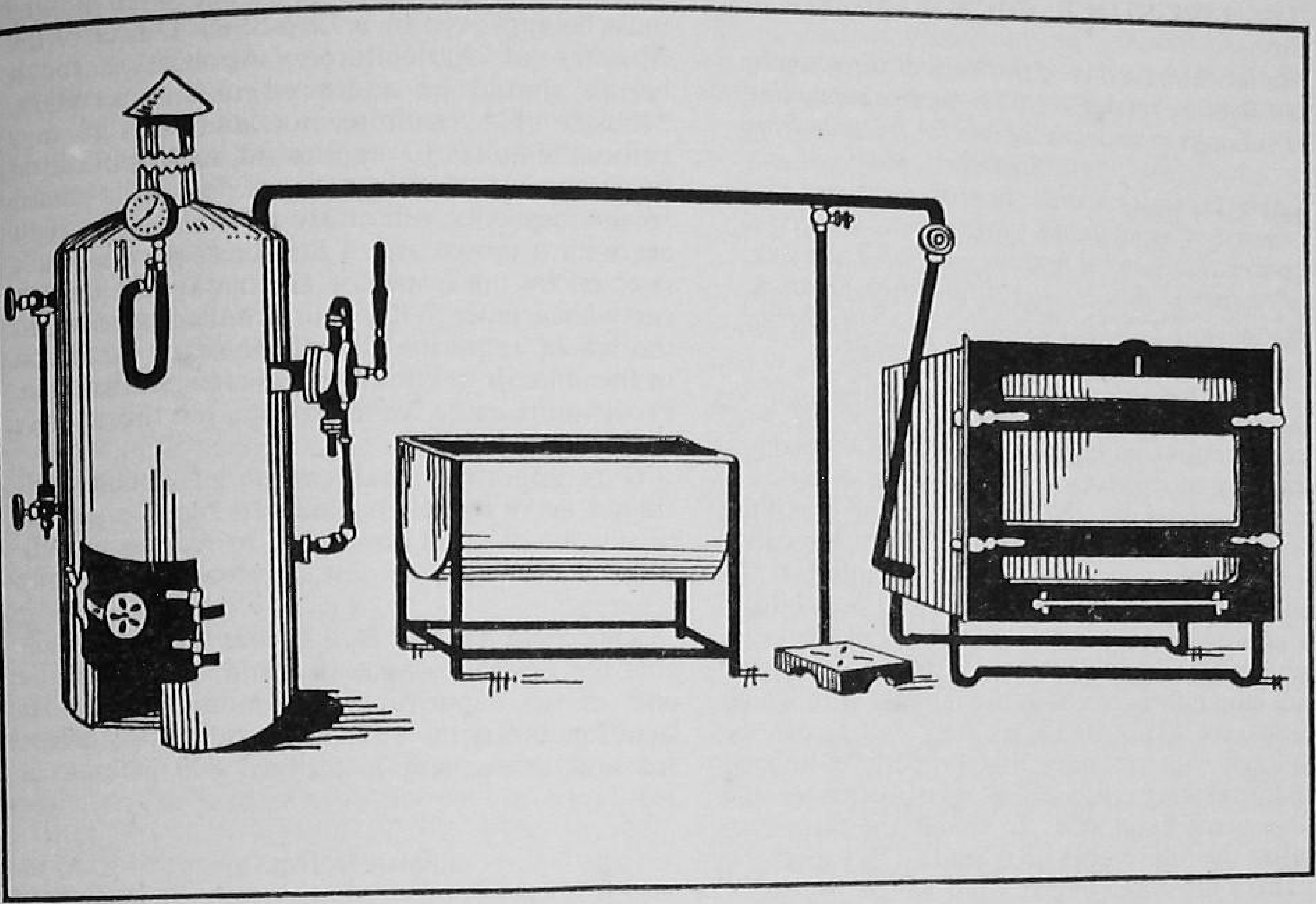
PREMIUM BULLS.

Grants.

Under the scheme for the improvement of livestock, grants are made by the Ministry of Agriculture to Societies of farmers to permit them to employ the services of a good bull. This takes the form of a grant towards the purchase cost of approved bulls. This scheme is of great value in districts with small herds, though there are apt to be risks in the spread of certain diseases and particularly abortion and trichomoniasis.

ARTIFICAL INSEMINATION.

This refers to the collection of the male sperm or germ cells and the artificial introduction of these into the female breeding tract by a veterinary surgeon or other qualified operator. The particular advantages of this system of breeding are that the services of a proven or good sire can be made available to a larger number of females. In normal breeding practice one bull will serve from 30 to 40 females a year, whereas with artificial insemination the number of matings can be increased to 300 or 400 or more per year. The system is of particular value in intensive dairy farming districts with small-sized herds. Artificial insemination makes use of the fact that it is possible to dilute the semen collected from the bull and to divide it so that several cows can be fertilized from each ejection of semen. An artificial cow or a teaser cow is employed for the collection of the semen in an artificial vagina and this is carefully diluted and preserved for insertion in cows in season.



STERILIZING OUTFIT.

In this country artificial insemination is under the control of the Ministry of Agriculture and powers have been given to the Milk Marketing Board to establish suitable centres. Several private centres are also in operation and all are under strict veterinary supervision and control. The idea is fundamentally sound, since it makes possible the more rapid improvement of livestock by the wider utilization of proven or good sires; it is less likely to spread disease, which is the great objection to the use of Ministry premium bulls; while artificially inseminating cows sometimes proves more effective than natural services in getting shy cows to breed. There are snags attaching to the development of the system. Proven bulls are difficult to find and it is not possible to cater for a radius of more than 10 to 15 miles around the artificial insemination centre. Outbreaks of foot and mouth disease in an area might prove troublesome in delaying services.

GRADING-UP.

Grading-up Register.

The leading breed societies have schemes for accepting foundation cows that conform to the type of the breed concerned into a grading-up register, to permit their progeny being graded-up to pedigree status by the continuous use of pedigree sires. The breeds in question are Shorthorns, Friesians, Ayrshires and Red Polls. An animal with four crosses of registered sires is regarded as eligible for the pedigree herd book, assuming that the original foundation cow was accepted as being of suitable type and conforming to the characteristics of the pure breed. In the case of Shorthorns in particular many of the non-pedigree foundation animals have many generations of Shorthorn breeding in their constitution. It is possible however to grade up to a pure-bred status from cows that originally belonged to another breed. In this case it takes seven or eight generations to eliminate the characteristics of the original "foreign" breed. Recently there has been a tendency to cross Shorthorn herds with either Friesian or Ayrshire bulls with the object of changing the type to Friesian or Ayrshire. Assuming that a Shorthorn breeder wishes to change to Friesian type by the use of pedigree Friesian bulls, the influence is likely to be along the following lines generation by generation:—

Generation	Friesian influence per cent	Shorthorn influence per cent
1	50	50
2	75	25
3	87·5	12·5
4	93·75	6·25
5	96·87	3·12
6	98·44	1·56
7	99·22	·78
8	99·61	·39

The grading-up process is the cheapest method of effecting improvements, but to be most successful

it demands the use of good sires and the elimination of females that do not conform to the standards desired. These standards may concern productive capacities and type characteristics.

The Agricultural Show.

The Show-Ring.

This was the pioneer effort to raise the standard of livestock. It is now associated closely with the work of breed societies who award a part of the premiums in the pedigree classes, and nominate panels of approved judges. The show-ring is chiefly of value in respect of conformational features, as it is not always linked with actual productive capacities. Exceptions are being made increasingly in special dairy classes where a minimum milk yield in the previous year may be required, or the cow or heifer will be required to yield a minimum amount of milk in the show-ring after having been judged. The London Dairy Show requires production tests and in this case an animal is not eligible for inspection that has not passed through the milking trials. In the milking trials an animal is disqualified if she produces milk at any one milking that is deficient both in solids not fat and in butter fat.

Unfortunately no serious attempt has been made to study such points as economical milk production based on food consumption in relation to milk out-put. Many agricultural show classes serve no useful purpose in promoting live-stock improvement. Examples of this kind are classes for non-pedigree animals that often contain cross-breds—such as Shorthorn-Ayrshire: this produces a very pretty show cow, but serves little purpose in the main scheme of breed improvement.

Among the tragedies of the show-ring are the forced feeding and training that live stock are expected to undergo before they can meet with the approval of the judges. These practices grew with the development of a race of show specialists more concerned with winning prizes than achieving breed improvements. These customs date back to the middle of last century and the habit of piling a superabundance of soft flabby fat on many females and bulls has had regrettable consequences. If it means fattening bulls and young breeding stock in order to win prizes, the show-ring should be avoided by the young breeder who is anxious to effect real breed improvements. The fattening of females in particular may interfere with fecundity and milking properties in later life. In so far as bulls are concerned, it is wasteful, though the fattening of an animal—usually of the dual-purpose type—is often a means of hiding conformational defects; it is therefore apt to be deceptive.

Breed Societies.

The Herd Book.

Every pure-breed has its own society to register pedigrees in the herd book, but these societies also award premiums at shows and undertake general publicity work to popularize a particular breed. Some societies have grading-up schemes, while those particularly interested in milk-production have a register-of-merit scheme for cows and bulls of proven yielding or siring properties. It is the duty of a breed society to safeguard the purity of breeding and the type of the breed concerned. The great weakness of breed society activities in this country is that it is left to the individual breeder to practise selection from within the group of animals born in a herd, all of which may be of pedigree breeding. "Pedigree" in other words merely means registered breeding and not necessarily that it is of worth-while merit.

Milk-Recording.

Yields of the Individual.

No dairy farmer who seeks to be efficient can afford not to record the yields of the individual cows in the herd. The objects and advantages of recording are:

1. To discover the most satisfactory producers both in respect of quantity and quality. It is impossible to judge yielding capacities from the external appearances of the cow. Similarly there is no definite certainty that cows giving a large quantity of milk after calving down will give a large lactation yield. Some animals give a large yield for a short period and then dry off quickly. Others give an average yield and keep it up for a lactation of satisfactory length, thereby giving a satisfactory lactation yield. Cows not yielding up to a satisfactory standard should be culled, as these will be unprofitable animals if retained. There are possible exceptions, such as animals that have not been able to give satisfactory results owing to accidents or illness and whose breeding justifies their retention for the sake of any heifer calves they may produce. Quality of milk is also important. Animals that average little more than the presumptive legal minimum for the lactation are likely to be a source of trouble through low butter fat at certain periods of the year. When butter or cheese is being produced, the richer the milk, the better is the yield of butter or cheese per gallon of milk utilized.

Room for Improvement.

That there is considerable room for improvement in the yielding capacities of herds is proved by the difference in the average yield of cattle kept in recorded herds as against ordinary commercial herds. No one should be satisfied with an average of less than 600 to 700 gallons per milking animal per year, whereas it is doubtful if the figure is much greater than 450 to 500 gallons in ordinary herds.

2. It becomes possible to feed and manage

cows on a more scientific and economic basis. Many cows fail to give satisfactory yields because they are treated as the rest of the herd. The institution of correct methods of feeding and rationing will often increase the milk-production materially. Ideal recording would take into account such factors as actual food consumption in relation to milk output. There is good reason for believing that some animals are better utilizers of the food consumed than others.

3. Regular weighings are a check on the efficiency of the milking process and also on the health of individual cows. A sick cow is often first observed through a sudden fall in milk yield. There are other causes for sudden falls, such as a change in feeding or weather conditions, but when this happens the fall is general throughout the herd.

4. The progeny of high-yielding cows are worth more when marketed, so that recording is a means of improving the capital value of a herd.

5. Recording tends to stimulate the interest of workers in the achievements of the cows in the herd. This leads to greater labour efficiency, since the cows begin to be treated as individuals worthy of study and good attention.

Organization of Milk-Recording.

The present organization of milk-recording in England and Wales is through the National Milk Records scheme operated by the Milk Marketing Board, of Thames Ditton, Surrey. A National Advisory Committee representative of all the important cattle-breeding and milk-recording interests advises the Milk Marketing Board on important matters of policy. Milk-recording is arranged so that members join a Senior or a Junior scheme. The Senior scheme provides for the recording of yields either daily or one day a week, with provision for butter-fat testing and periodical check inspections by an official recorder. The Junior scheme provides for recording yields once a month, but the figures so obtained are not accepted by the breed societies for official yield purposes, but are intended to serve as a guide to the commercial breeder where no particular interest is taken in breeding pedigree or grading-up animals. In the majority of cases it is expected that once experience of recording procedure has been obtained by membership of the Junior scheme, there will be a transference to the Senior scheme.

Official Milk-Recording.

The milk-recording year is reckoned to be from noon of the 1st October to noon of the following October 1st. Members participating in official milk-recording in the Senior and Junior schemes are required to conform to the rules and are subject to the control of the Committee of the County or district branch in which the herd is registered for membership. The more important of these require that the member shall provide and keep in proper order a pail and spring balance, of a kind approved by the Board, registering quantities of milk to a quarter of a pound. Milking machine users having a mechanical recorder may have these accepted. All cows in the Senior scheme must be identified by means of ear-numbers inserted by the Milk-Recorder, who makes official visits eight times a year. The yields must be entered up on weighing sheets and in the annual register, documents that are supplied free by the Milk Marketing Board. The dates of calving or abortion, of entering the milking herd, together with service dates must be entered on the weighing sheets.

Members of the Senior scheme may participate in the Bull Progeny Testing Scheme, the object of which is to provide records of the progeny of bulls and certificates relating to such bulls.

The cost of recording works out at about 5s. per cow per year, with an extra charge of 3d. per sample of milk tested for butter fats.

THE MANAGEMENT OF THE DAIRY COW

This section deals with a subject fundamental to successful milk-producing and here the following are among the topics discussed:—Problems of mating and pregnancy; fitting the Cow for high production; the Cow at Calving; Milk-secretion; Lactation and production factors; Composition of Milk; Colour of Cream and Butter; Taints in Milk.

Early Calving.

Good management is fundamental to successful milk-production. Assuming that a heifer has been satisfactorily reared, the first problem concerns the age at which a heifer should be mated. Marked variations occur in practice, some through design and others through bad management. The gestation period of the cow is 280 to 285 days, or just over 9 months. A rough and ready guide is to subtract three months from the service date and add seven days to give the date of calving. The majority of breeds are calved down at from 27 to 33 months of age. The exceptions are in the case of Channel Island breeds, which calve down at two years old. Provided heifers are properly reared, there is no point in favouring calving down at ages greater than 2½ years old. Too many heifers waste productive time by not calving down on the young side. There is no evidence that early calving is detrimental to health, whereas there is some evidence that dairy characteristics are developed. It is necessary to recognize that where some design enters into dairy farming practice as regards maintaining a level production of milk, an attempt is usually made to have regular calvings month by month, with the greatest concentration of calvings in the autumn and winter. In the case of heifers, however, the most favourable time for calving is in the autumn, since these animals have the opportunity of fitting themselves for their first lactation on pasture. Nutritional troubles are avoided in this way. This means that it is customary to start mating heifers in early winter, though obviously in a regular breeding herd one has to mate some heifers at other periods of the year, on the grounds of age.

It is a point of importance that animals calving in autumn or early winter give from 10 to 20 per cent more milk in their lactation than spring and summer calvings. The reasons for this are that cows fit themselves for high production more successfully on grass; there is freedom from the flies that cause gadding in summer and reduce production; and finally at the end of the winter the yield is flushed again when cows go on to new spring grass. It is always a debatable problem as to whether summer or winter milk production is the most profitable, but there are many points in favour of concentrating on a high winter output. The first is the question of price, which is weighted in favour of winter milk; the second is that good keeping quality is more easily achieved in winter; the third concerns the utilization of labour to maximum advantage at a period of year when there is not much pressing work on the land. The cow herself is apt to be the biggest obstacle to calving down in early winter, since cows do not come so readily into season when tied up in sheds in winter.

Better Knowledge.

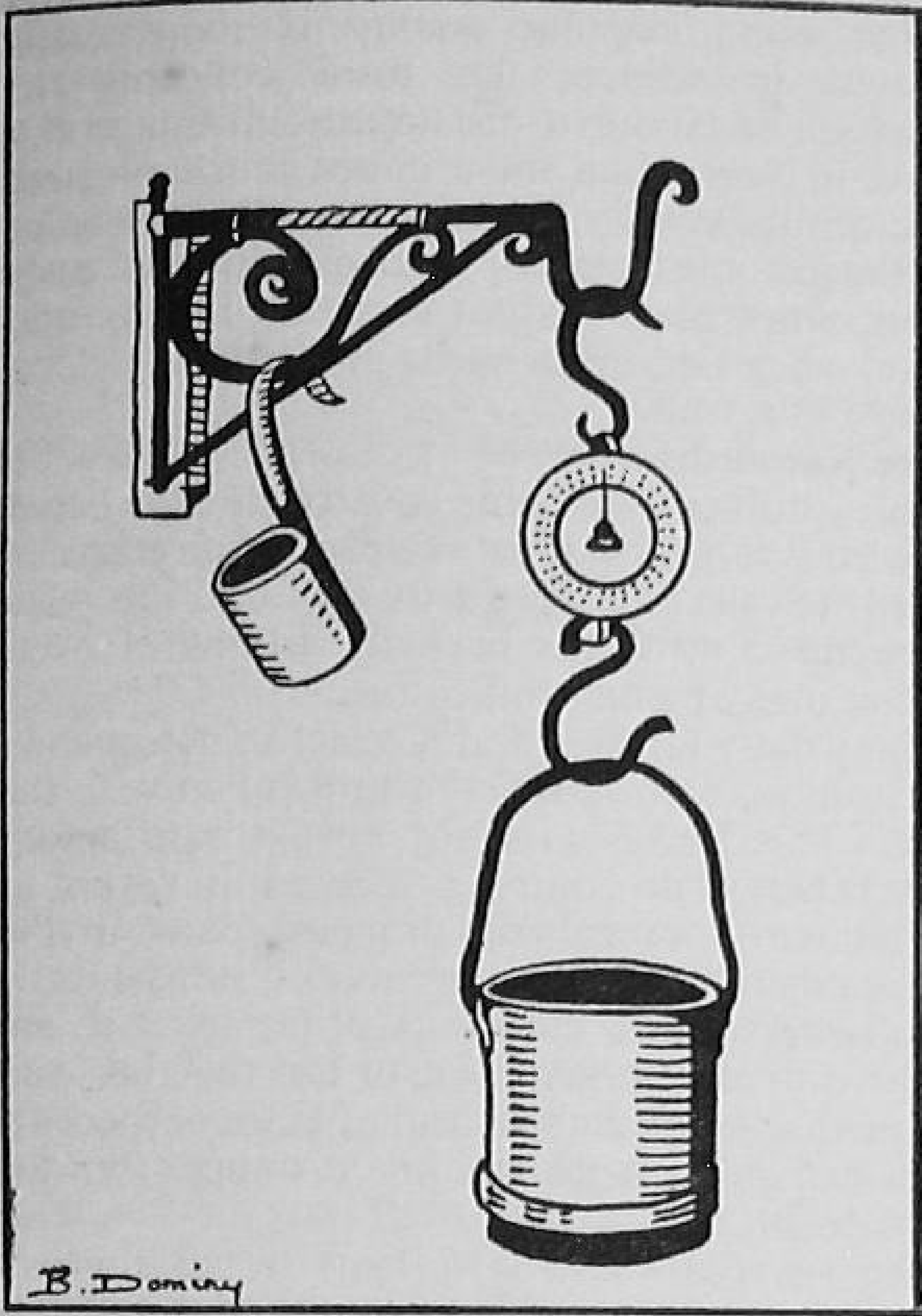
This problem is being overcome by better knowledge possessed by veterinary surgeons in regard to sterility, silent heats, etc., so that veterinary control has been the means of overcoming many former difficulties.

Many dairy farmers find it easier to detect cows in season or " on heat " if a bull is run with the herd. This however is not always satisfactory in that there is no control possible with regard to the regularity of calving amongst cows in the milking herd. The system works satisfactorily with heifers of a similar age group that are required to calve down more or less together, and this method saves a good deal of labour especially when heifers are kept at some distance from the homestead.

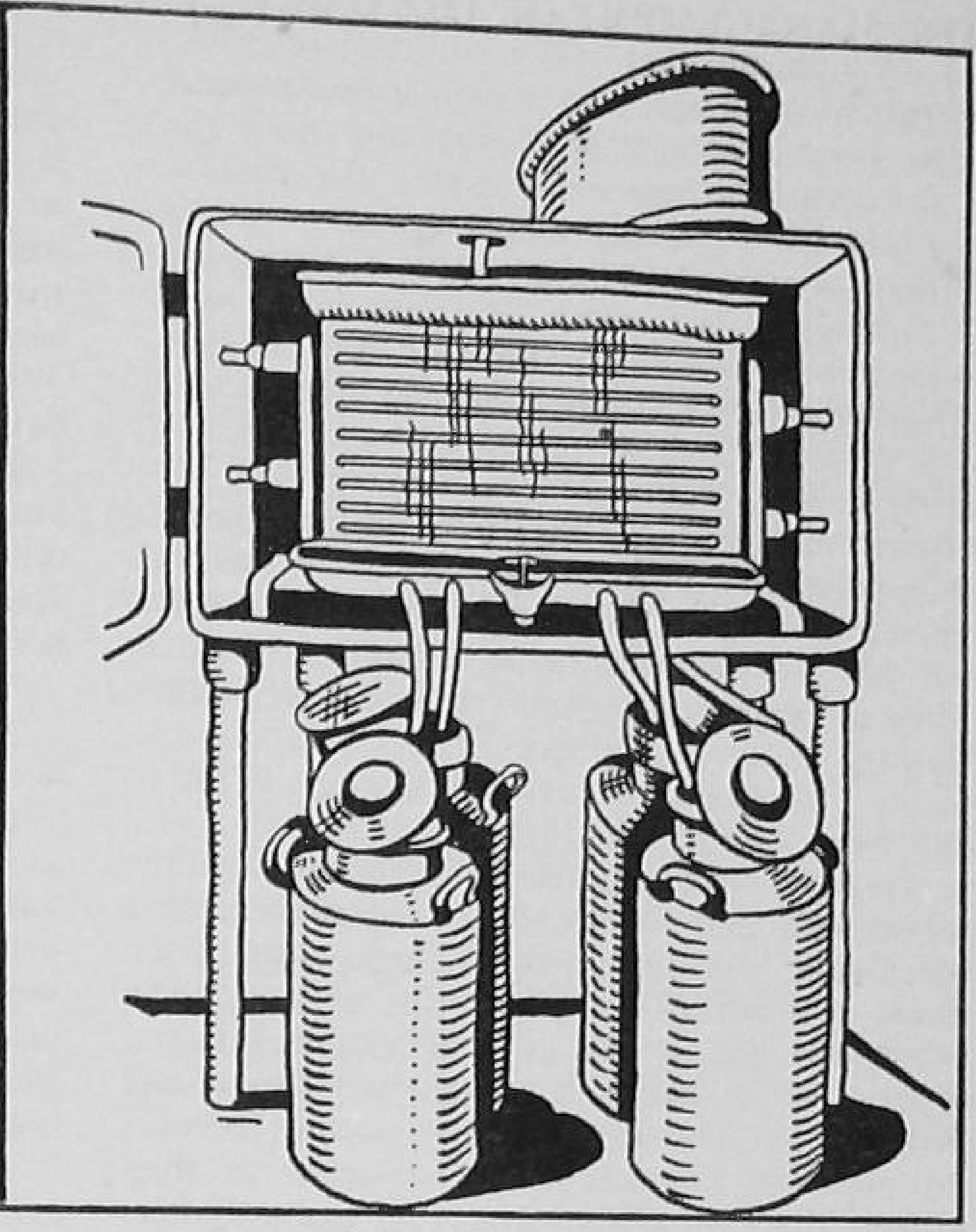
The signs of oestrus (" heat ") are that an animal becomes restless, twitches the tail frequently, goes off feed and when outside will either jump on other cows, or is jumped on. Heifers in particular are prone to wander off from the rest of the herd and bellow, and when cows are in milk the yield is often down by several pounds. Animals vary in their reactions at this period. Some show signs of a depression in the loin region, thereby elevating the tail head. In some cases a slimy discharge occurs from the vulva and about two days after the cow has gone off heat it is customary to find a slight discharge of blood. This sign is specially helpful in winter when cows are tied up and when their heat period has not been detected. Such an animal should be noted and turned out with the bull in 17 to 18 days time. The periods of heat occur every 21 days, the cow remaining in season for about a day. The cow must be mated during the period she is in season. Cows that are in milk are best kept tied up after mating, even in summer, until they go out of season.

Signs of Pregnancy.

The common signs of pregnancy are that heifers and cows fail to come in season, and after the fifth month it is sometimes possible to " knock " the calf by pressing in the right flank with the backs of both hands. In the case of heifers that are in calf, after the fourth month the fluid drawn from the teats is thick and sticky. With veterinary control of herds however, it is possible to detect pregnancy from an examination of the uterus and routine examination by qualified practitioners can be recommended.



MILK RECORDING BUCKET AND BALANCE.



MILK COOLER.

The signs of approaching parturition can be quickly ascertained by careful observation. In the normal order of events, the first signs are that the udder begins to swell, and particularly about a week before calving takes place. In farming language the animal is said to be "springing for calving." Associated with the filling of the udder is the swelling of the vulva, though this may happen several weeks before calving takes place. About 24 hours before calving the part on each side of the tail head shrinks (dropping of the slacks), and this is the surest sign of imminent parturition. Slime is often passed for a day or two before calving, but just before calving the animal tends to be restless, and if in a field separates herself from the rest of the herd. The immediate sign is the appearance of the water bladder.

FITTING THE COW FOR HIGH PRODUCTION.

A Liberal Diet.

Proper feeding is fundamental for satisfactory milk-production, but feeding will only give the most satisfactory results with cows of good yielding capacities. Dairy farmers in the United States for many years past have stressed the importance of a conditioning of pregnant animals for the succeeding lactation which Boutflour has aptly described as "steaming up." Fitting or steaming up the in-calf heifer or cow simply means adopting a liberal diet for the last six or eight weeks of pregnancy so that the animal lays on good flesh to enable her to withstand better the strain of high-production. No high-yielding cow at the peak of production can consume food in sufficient quantity to equal the output of nutrients in the form of secreted milk. The cow is forced to draw on her natural body reserves and thus a fit cow will not only give a higher yield but will also feel the strain less than a cow calving down in poor condition. The ideal type of fitting ration is one that is fairly laxative, bulky and light. In successful dairy cattle management, cows must be treated as individuals and for this reason intelligent feeding has to be practised in accordance with the particular needs of each animal. When there are no food restrictions conditioning for calving may justify feeding 6 to 8 lb. of a balanced mixture daily for the last two months of pregnancy. It must be emphasized that it is desirable to prepare the cow slowly, rather than to try to force the cow by high feeding over a shorter period, while it is equally desirable that a week before calving there should be no attempt made to feed to appetite. The concentrated ration should be reduced and the ideal form of ration at this period is a mixture of bran, linseed cake and crushed oats. With pregnant cows, as with all livestock, a careful watch should be kept on the bowels, for constipation must be avoided at all costs. Cattle running

out on grass very rarely give any trouble by virtue of their natural diet. The common remedy for constipation is a dose of a half to one pound of epsom salts in a drench of warm water.

In some quarters it has become fashionable to suggest that in-calf animals should be milked about ten days before they calve, if their udders are unduly distended and inflamed. The advantages claimed for the practice are that it prevents inflammation of the udder and reduces the risk of milk-fever. The practice is far from sound, however, for there is no evidence to show that the udder suffers any injury from the natural accumulations prior to calving. Furthermore such pre-calving milking does not allow the calf to enjoy the advantages of colostrum, since the milk at calving ceases to be of that character.

The Cow at Calving.

Calving.

The act of calving is a perfectly natural function of the cow, and under natural conditions there are rarely any serious difficulties experienced. When animals are kept under more artificial conditions, the sytem of feeding and management prior to calving is important. In summer there are no objections to leaving cows outside, but in winter the ideal is to place the in-calf cow in a well-bedded and properly disinfected loose-box several days before she is due to calve. This provides the animal with more comfort. Loose-boxes are not always available, however, and though it is far from ideal, many cows give birth to their calves in the milking shed. In this case, the cow should be well-bedded in her stall. The skilled cattle-man learns from experience when help is necessary at the time of parturition. Often more harm is done by being inquisitive and trying to force nature, than allowing the animal to take her time. If examinations are necessary, in cases where the progress of labour is slow, the greatest care should be taken to ensure that the hands and arms are clean, and if it becomes necessary to attach ropes to the unborn calf, these should be disinfected. When help is given to the cow in a difficult calving case, the pressure on the calf should be applied to coincide with the straining motions of the cow. For the novice, it is advisable to call in a veterinary surgeon in difficult cases, since proper veterinary attention prevents many of the errors which so often lead to complications after calving. Veterinary aid should also be sought when cows hold their "cleansing," which is more likely to happen when there is abortion infection.

After the calf is born a warm drink of gruel for the cow is helpful if she is at all exhausted, but in any case she should be given a drink of water at blood heat. An hour later a warm bran mash can be given, but for the first two days after calving no attempt should be made to feed to appetite, and, even then, there should be a steady increase in the allowance of concentrates. Thus, one is well-advised to start feeding 3 or 4 lb. of concentrates daily and increase by 1 lb. daily until the cow reaches her maximum allowance based on the yield of the animal. For the first two days after calving no attempt should be made to milk the cow dry, while if the udder is unduly inflamed, it can be eased by rubbing with a good udder ointment.

Weight of a Calf.

The weight of a calf at birth depends upon the breed. Bull calves are usually heavier than heifer calves. The weights differ from about 55 lb. in the case of a Jersey to about 90 lb. in the Friesian. Shorthorns average between 76 and 85 lb.

Milk Secretion.

Milk is Secreted.

Milk is synthesized from the blood conveyed to the udder by two large arteries and subsequently distributed around the udder cells by a fine network of blood vessels. From the cells or small cavities the newly-formed milk passes down ducts that lead to a large cavity or cistern in each quarter, located above each teat. This large cavity is composed of thin layers of tissue which act as pockets for the storage of the milk which is secreted continuously by the milk cells when the cow is in milk. Cows differ in their storage capacity, but the activity of the secreting cells is stimulated by the milking process as a result of a hormone secreted by the pituitary gland, so that it must not be assumed that the milk extracted at one milking represents only the accumulation of production since the previous milking. The teat is the outlet for the milk, and from the storage cavity there is a channel that leads to a cavity in the middle of the teat. From there it is conducted by another channel to the teat opening. This final duct is encircled by a muscle which serves to retain the milk stored between milkings, though it is not proof against the admission of bacteria. In order to maintain a healthy udder it is of the utmost importance that care should be taken in the manner of drawing off the fore-milk (the first few draws) since it is possible for bacterial infection to be forced into the udder. The right and left halves of the udder are divided by a ligament that carries the weight of the udder and each quarter is divided off from the other. The blood supply leaves the udder after the secreting cells have extracted the milk-making materials, by way of the milk veins on the underside of the belly and passes towards the heart. There is also an upward route, so that it is not a safe deduction to assume the absence of large external milk veins is an infallible sign of a poor milk cow.

Output of Milk.

The output of milk from the various quarters

is invariably greatest from the two hind quarters. Thus a cow yielding 20 lb. of milk at a milking will generally produce about 8 lb. from the front two quarters as against 12 lb. from the two rear quarters.

It can be readily understood that when a cow is unwell, and anything affects the blood supply that the secretion of milk is interfered with.

Lactation and Production Factors.

Lactation Period.

This is partly dependent on the quickness or otherwise of mating after calving. A fairly long lactation is desirable if a good yield is desired, the normal being from 43 to 45 weeks, but it is equally necessary for a cow to have a period of about 6 to 8 weeks dry if a good yield is to be given in the subsequent lactation. It is a theoretical ideal to get the cow calving down once every twelve months. Under these conditions the heifer or cow should be mated not sooner than three months after calving. Under-sized or backward heifers can be given a longer rest with advantage before re-mating. Similarly cows that have the tendency for a naturally short lactation period should be re-mated when they first come into season after calving.

The length of the lactation period is important in estimating the value of an animal's milk record. It is desirable that official records for qualified bull-breeding cows should be standardized on a basis that would allow for variations resulting from the time of re-mating after calving. Thus it is a too frequent practice to delay re-mating an aminal if there is any doubt about its satisfying the yield qualifications, and it is desirable that buyers of bulls should examine milk records very carefully in this respect. With cows of normal yielding ability it can be assumed that for every month's delay in re-mating after the normal three months period has elapsed, the lactation yield is increased by 40 to 50 gallons.

Two Common Methods.

Cows will produce more milk annually and for a longer period if allowed a rest of six to eight weeks than if milked right through until the next calving. The rest is considered to be of much more importance in the case of animals carrying their second calf than others, on account of the additional factor of body growth. One of the principal objects of the rest period is to allow the cow to calve down in good condition. Some high yielding cows do not dry off naturally, and there are two common methods of bringing this about. The first is to reduce the number of milkings to one per day, then to every other day and gradually lengthen the intervals until the cow is not worth milking. This is the commonest system and the one that is regarded as the safest method of preventing the development of udder troubles. The second method is suddenly to stop milking the cow altogether, cutting out the concentrated ration so that there is no stimulation of production. Where the udders are healthy, this method is quite safe and is simpler. The udder will fill with milk and may get hard for a few days, but gradually the milk will be re-absorbed.

In making comparisons between the yielding capacities of animals, the cow usually reaches her highest daily yield in the lactation between the 18th and 28th day after calving, while the maximum lactation yield may be reached at the 4th or 5th lactation. The yield of a heifer is normally about 30 per cent lower than her yield when mature. A second calf cow is about 20 per cent lower and a third calf cow about 10 per cent lower than the mature yield. Many breeders cull their heifers after their first calf if they do not reach a satisfactory yield. Generally the yielding capacities of a heifer are a clue to her productive qualities when mature, assuming that she has been properly managed and fed. My own requirements in a Shorthorn herd are that heifers should yield a minimum of 30 lb. and mature cows 50 lb. milk per day to justify retention when in full milk.

Frequency of Milking.

The frequency of milking has some influence on total output. Thus with high yielding cows thrice-daily milking increases the out-put of milk by from 10 to 20 per cent. It is sometimes asserted to be essential that high yielders should be milked thrice daily on humane grounds, but the factor which most frequently operates against the practice is that of labour, for which reason it is not a popular custom in this country. Where twice daily milking is practised, the ideal is to milk at twelve hour intervals, but this again complicates labour problems, so that on the average dairy farm the intervals are unequal, being in the nature of 14 hours between evening and morning and 10 hours between morning and evening milkings.

Butter Fat.

Butter-fat production during the lactation is influenced largely by the quantity of milk yielded by the cow. Thus during the period of maximum milk-production the fat percentage is lowest, and as the yield declines the fat percentage increases. The highest fat averages are generally returned during the first three lactations, but the factors tending to low butter fat production are the individuality of the cow (high quality is generally inherited), high yields, the beginning of a new lactation, the system of feeding, lack of condition, warm weather, irregular milking intervals, the feeding of certain fatty acids (especially cod-liver-oil) and failure to strip the cow thoroughly.

THE COMPOSITION OF MILK.

"Appeal to the Cow."

The Sale of Milk Regulations provide that a sample of milk containing less than 3 per cent of butter fats or less than 8·5 per cent of other solids is to be presumed for the purposes of the Foods and Drugs (Adulteration) Act, not to be genuine until the contrary is proved. Owing to the ease by which milk is adulterated through the addition of water and the need for safeguarding consumers and purchasers of milk, failure on the part of the producer to sell milk conforming to the legal requirements renders him liable to legal proceedings. Investigations at the Midland Agricultural College in 15 herds over three years showed that the average analysis of milk was 3·71 per cent fat and 8·75 per cent solids-not-fat, but that in over 8 per cent of cases cows naturally gave milk below the minimum standard of 3 per cent fat and in nearly 15 per cent of cases yielded milk below the minimum standard of 8·5 per cent of solids-not-fat. Similar results have been found in other research investigations, and it is important therefore that dairy farmers should be aware of these facts. Fortunately it is possible for the honest producer to make application to the local authority in the event of a threatened prosecution for an "appeal to the cow," to prove that the milk was genuine. Such an appeal must be lodged within sixty hours of the receipt of notification that the milk has been found below the standard. It can never be regarded as satisfactory that milk should be marketed that requires proof to be furnished that it is genuine, and it is desirable that milk-producers should realize that quality is as important as quantity in judging the milk records of breeding stock.

Abnormally poor milk is produced by some individual animals in most breeds. Individual testing for butter fat and solids-not-fat is therefore important especially in bull-breeding herds. Friesian herds that formerly were very poor in butter fat have been improved in many cases by selective breeding. This however is a long-term method of correction.

Intervals Between Milking.

The practical points of immediate application relate to the intervals between milking. Butter fat deficiencies are specially marked at the morning milking when cows are milked early the previous afternoon and when at their peak of production. The ideal milking intervals from the milk-quality point of view are twelve hours where twice-a-day milking is practised. With modern high labour costs this is rarely possible on a large milk-producing farm. More frequently the morning milking will commence at 6.0 a.m. and the afternoon milking at 4.0 p.m. or even earlier. In these cases it is an advantage to milk the highest yielding cows first in the morning and last at the afternoon milking and also to ensure that the milk from high yielders and low yielders is equally divided amongst the churns in which milk is sent from off the farm. Many dairy farmers fit a device to their coolers that delivers milk into three or more churns at the same time, thus effectively mixing the whole of the milk and ensuring evenness of composition as between one churn and another. Equally important is the efficiency of the milking process itself, especially as regards milking the cow dry without leaving the strippings behind. The last drawn milk or strippings contains from 8 to 9 per cent of fat. As deficiencies are frequently met with when cows are turned out to grass in spring, it is important not to have too high a proportion of spring calving cows in the herd.

It is commonly supposed by many milk-producers that the system of feeding or adequacy of rations affects the quality of milk. This viewpoint finds little support from experimental work when using ordinary foods. Feeding makes a material difference to quantity produced, but has a very small bearing on the quality.

Recent investigational work indicates that deficiencies in solids-not-fat may be due to infection of the udder with mastitis organisms, even though this trouble may not be active, but sub-clinical.

THE COLOUR OF CREAM AND BUTTER.

Pigments.

All creams are not the same colour. It is well-known that Jerseys and Guernseys produce cream and butter which are deeper in colour than those produced by Friesians and Ayrshires, for example. This colour is derived from pigments consumed in the food and some animals have the capacity of transmitting more of this pigment to their milk than others. The pigments in question are chiefly carotin, a substance found in green grass and plants, early-cut hay, dried grass, grass silage, carrots and yellow-coloured roots. The colour of the cream must not be confused with the quality of butter fat, but a good colour is an added asset when milk is sold in bottles. As the greatest colour deficiency occurs in winter, adjustments to the types of foods fed often correct a tendency to produce pale-coloured milk.

TAINTS IN MILK.

Causes of Tainting.

Good milk should be palatable and free from objectionable taints and odours, but even under the best conditions of production there are occasions when complaints of taints may be experienced. There are two main causes of tainting. The first relates to the fact that milk readily absorbs taints from the atmosphere of a

cowshed, and the second is that cows can transmit a taint to milk from foods they have consumed. To be safe it is desirable that known tainting foods should be fed after and not immediately before milking.

The common foods which give rise to tainting are swedes, cabbages, morrow stem kale, sugar-beet tops, certain forms of silage and molassed sugar beet pulp. Certain weeds are also known to produce objectionable taints and particularly garlic and mayweed.

Other taints are derived from the presence of undesirable bacteria, often due to lack of cleanliness in the milking process, as also to contaminated water.

Milk that contains traces of copper, resulting from the use of utensils that are dilapidated or not adequately tinned, is liable to develop an oily taint due to the oxidation of the fat. Worn milk coolers, and strainers with copper gauge are chiefly responsible for this taint which is more prevalent in winter than in summer.

Bad or inadequate cooling tends to emphasize any slight taint or smell. The lids on churns in which milk is being stored over-night should be left loose as a means of ventilation.

CROPS ON THE DAIRY FARM

The crops that are to be grown on the Dairy Farm must be governed by the availability of purchased feeding stuffs and this topic is reviewed at the beginning of the Section. The foods grown are considered under the following heads:—Grassland. Supplementary Crops during the Grazing Season; Lucerne; Legume-Cereal Mixtures; Brassicas; Maize; Hay; Dried Grass; Silage; Marrow-Stem Kale; Thousand-headed Kale; Cabbages; Sugar-beet tops; Mangolds; Swedes; Straw; Home-grown Grains.

The following subjects are also discussed:—Crop-rotations. Pasture requirements. Hay requirements. Straw requirements. Other crops. Root and Forage Crops all the year round.

Flexibility.

Dairy farming is practised under such widely differing conditions that there is no uniformity in the cropping systems followed. War-time conditions taught the dairy farmer to concentrate on making his farm more self-sufficient than was the case when he could buy an abundance of cheap imported concentrates. The dairy farmer will usually find it convenient to model his cropping programme on the basis of economical milk-production, but if the cost of producing essential foodstuffs is greater under home-grown conditions, then there must be the flexibility in the farming system to take advantage of cheaper imported foods when these become available. The average holding devoted to milk-production is relatively small, by contrast with holdings devoted to corn growing. In normal times the availability of cheap concentrated foods enables dairy farmers on small acreages to intensify their production so that by the use of considerable quantities of purchased feeding stuffs the effective farming area of the average dairy farm is considerably increased over the actual area farmed. The same thing is true of milk-producing farms on the outskirts of large towns and cities when brewery offals are available in large quantities; normally these are used widely on the milk and feed system of dairy farming. In days before the War the grassland was limited in quantity and the manure produced by the cows found a ready sale to gardeners and allotment holders at prices in excess of its value for ordinary agricultural requirements. Intensive milk-production on a small area of land did provide problems concerning the utilization of the manure in inland districts where there was no market demand for the manure. It was then usually applied to meadow land to be mown for hay; and in some parts of Lancashire, Cheshire and Derbyshire there was evidence of too heavy a concentration of dung on grassland.

War-time experiences proved that these accumulated reserves of fertility produce very satisfactory crops when this grassland is ploughed up. Ley-farming, by its method of taking the plough round the farm, has not only provided better young pastures with increased stock-carrying capacities, but has also demonstrated beyond all doubt that the money formerly expended on buying imported foods can be adequately and economically utilized in using labour to grow crops at home. Over the greater part of the country it was usually cheaper to grow certain types of starchy foods at home than to replace with imported foods, and particularly where a high efficiency in crop production obtains. The greatest disservice ever rendered to the dairy farming industry in this country was the no-root cult. The acid-test of efficient dairy husbandry is not the question of yield per cow only, but the development of a healthy herd with a long milking life, kept on land that is using its accumulated fertility in the growing of crops that can be utilized economically for the support of the herd and its followers.

Natural Methods of Feeding.

In all the rival dairying countries, in successful dairying on the commercial farm, the emphasis has been placed on growing crops to satisfy the major needs of the herd. War-time conditions re-emphasized its importance in this country. High yields achieved under natural methods of feeding are of more value to the commercial farmer than the forced yields secured by specialist methods and artificial diets where there may be no extra margin of profit to be derived from the forced yields, while on the other side there may be evil effects upon the health and breeding life of the cow. There is good reason for believing that even in well-managed herds there were fewer udder troubles than before after the limitation imposed by war-time conditions on protein allowances for milking cows. The significance of good cropping to good milk-production is likely therefore to continue and increasingly the farm must now be utilized to absorb some of the money formerly expended on purchased foodstuffs.

Grassland.

Important Food.

Grass is by far the most important food in this country. It is also the cheapest source of food; but the efficiency of grassland is very dependent on the management meted out to it. As a result of the research work on grassland management, a new understanding obtains with regard to such matters as quality and productiveness. There are some districts with good natural pastures which are the result of good natural conditions and good management. Taking the country as a whole, however, there are too many instances of grassland that is worn-out or, at the best, only semi-productive. The war did a great service for

agriculture in ploughing out many of these old pastures, which when properly re-seeded were twice as productive as before and very much more nutritious; they were also efficient for a longer period in the grazing season than in their former state. Even before the days of widespread ploughing out and re-seeding, improvements made by phosphatic manuring in particular proved economical in the improved grazing returns, but with our present knowledge, ley-farming has marked a big step forward, though it is necessary to remind readers that the system has been long established as a feature of northern agriculture and is by no means new. The developments that really are new concern the utilization of species of grasses that have been selected for their leafiness. It is important that the dairy farmer, in designing the cropping of his farm, should pay the first attention to his grassland and he should be prepared to treat grass as a crop and to give to it the same thought and care that he gives to the arable crops of the farm.

The Grazing Season.

The grazing season normally extends from the beginning of May to the end of September. By good management the grazing season can be extended over a longer period, especially utilizing nitrogenous top-dressings in early spring to induce an early bite and also by the use of top dressings in the summer to extend the grazing available in the autumn. Much will depend on the weather conditions experienced as to the effectiveness of grass for meeting normal grazing needs during the grazing season. In the east and south-east of England it is a common experience for summer droughts to restrict the grazing during the middle of the summer, and it must be appreciated that no amount of nitrogenous top-dressings will maintain active growth in the absence of adequate rainfall. It is for this reason that many dairy farmers grow forage crops as an insurance against drought conditions during the summer months.

The system of controlling grazing and then resting grassland that has been grazed down is also more satisfactory than giving cows the freedom of a large acreage over which to roam. The electric fence has proved a very economical and satisfactory method of controlling cattle when large areas have been sub-divided into smaller grazing plots. The normal pasturage allocated to a cow is from 1 to 1½ acres, though this can be reduced both on good, well-managed pastures subjected to controlled grazing and where supplementary forage crops are grown for summer feeding.

As food is the most important single item in the cost of producing a gallon of milk it is important to recognize the efficiency of good grass in relation to low costs of production. Figures collected by the Economics Department of the Midland Agricultural College in 1933 from nine milk-producing farms during the summer feeding period of May 1st to September 30th gave the following comparisons:—

First Class	Percentage of total quantity consumed Starch Equiv.	Percentage of total quantity consumed Protein Equiv.	Ratio of Protein to Starch Equiv.	Cost per lb. of Starch Equiv. pence
Grass	73·0	66·5	1 : 6·8	0·57
Home-grown foods	3·0	2·5	1 : 8·3	0·79
Purchased foods	24·0	31·0	1 : 4·8	1·06
	100·0	100·0		

The range of dependence on grass in terms of Starch Equivalent varied from 91 per cent to 49 per cent. On the farm where the fullest use was made of grass, the food costs per gallon were only half those on the remaining farms. This example caused me to query the economic soundness of too great an intensification in dairy farming with a tendency to depend increasingly upon purchased foodstuffs to supplement a limited acreage of grass. It is not within everyone's power to increase the farming area in respect of grass to effect a saving in the cost of feeding cows in summer. Similarly where it is necessary to count on a definite amount of income it is not a practical proposition to reduce the size of herd to conform to the area of grass available when alternative sources of food can be purchased.

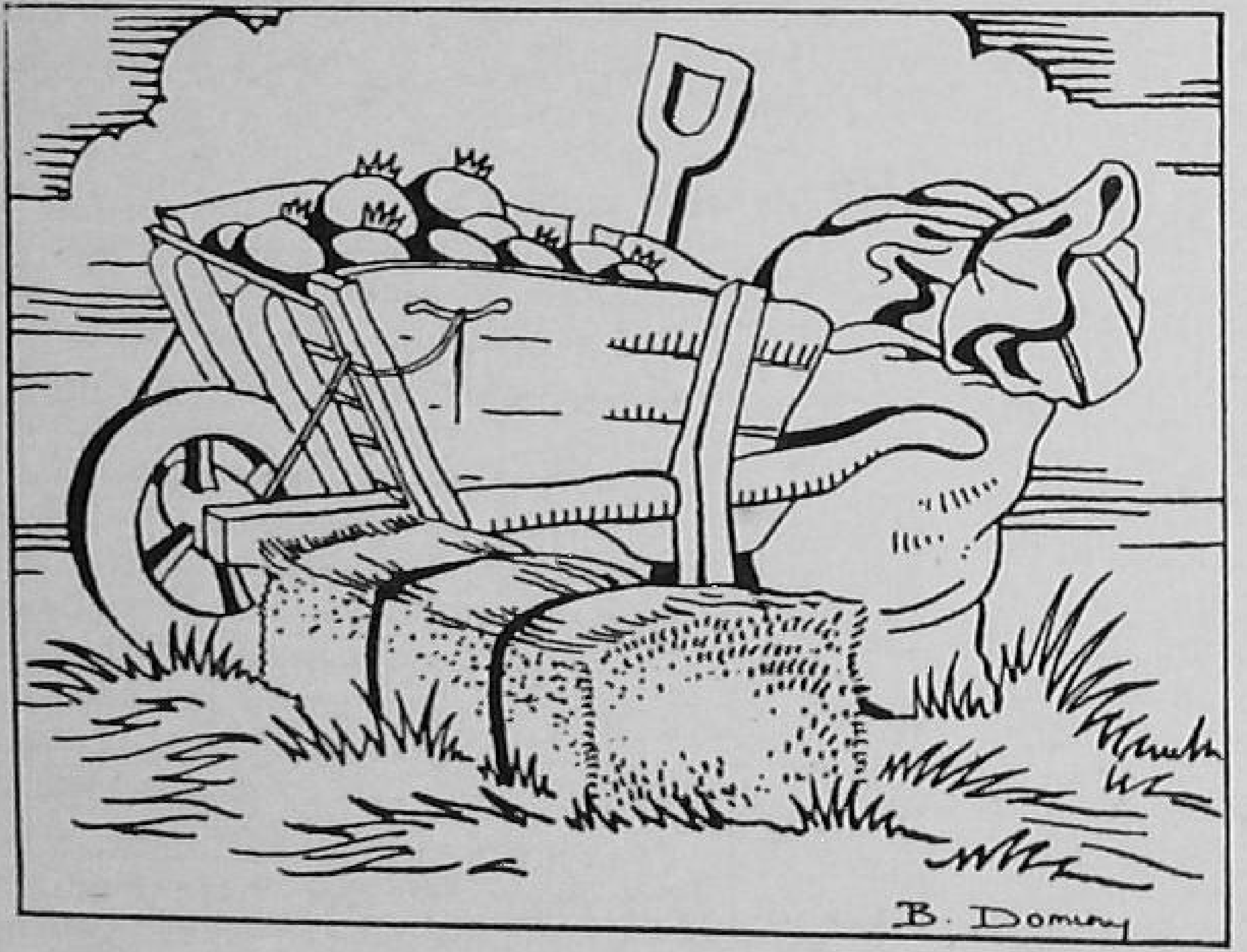
Well-Managed Land.

It is important to recognize that the virtues of grass presume that this is the produce of well-managed land. There are still too many who assume that grass is adequately manured through the excreta of well-fed cows. The actual truth is that phosphates and lime are essential as manurial supplements and that it is cheaper to feed cows through good grass encouraged in this manner than by concentrates. The appearance of the pasture and the manner in which it is grazed off is sufficient to indicate productivity and quality. Imperfect grazing of grass in itself will cause deterioration. Too often this state is encouraged by feeding cows heavily on concentrates when they are running on grass.

As pointed out in the section on feeding, closely grazed grass from good pastures is nearly twice as rich in protein as that produced from second-rate pastures where the herbage has lost its leafiness. From the standpoint of balanced feeding it is possible to have pastures that in the early part of the grazing season are too rich in protein-content for dairy cows. There are two ways of dealing with this; the first is to supplement the pasture with some starchy food like some of the maize products, sugar beet pulp or

even hay; the second is to encourage a longer growth of grass so that the quality is corrected in this way. Figures collected at the Midland Agricultural College in connection with the quality of grass mown for grass-drying at various periods of the growing season indicate that the protein quality is reasonably maintained to the end of the season, but when drought conditions are experienced the feeding value of the herbage is reduced since the grasses run to seed more quickly. Management and seasonal influences thus play their part. In this connection it has become popular to assume that grass should be eaten by stock at such a rate that it is never allowed to get ahead of the actual needs. If it does, then it is customary to suggest that the field should be topped with the mowing machine. In the drier areas of the country my experience suggests that under extensive grazing conditions, topping a pasture in this way is harmful to the needs of grazing, if a period of summer drought lies ahead. A surplus of grazing is a valuable standby during drought, while any apparent roughness during summer is readily grazed off before winter on well-fertilized fields by strong store cattle.

Teaching the Calf to Drink.



Foods for the Cow.

Supplementary Crops during the Grading Season.

Supplementary Feeding.

On the average farm, where grass provides the bulk of the summer feeding needs of the dairy cow, the period when supplementary feeding may be necessary as a result of drought conditions is from mid-June to the end of August. The normal deterioration in the feeding value of pastures also necessitates making provision for supplementary feeding that carries on into the autumn. The proper management and cultivation of grass itself often helps to extend the availability of adequate grazing, especially when controlled grazing and resting is practised. Recently seeded down pastures are invariably earlier than old pastures. A cutting for silage may often be made in early May and the aftermath made available for grazing by the middle of June. Similarly pastures that have been formed from a direct re-seeding in the spring will be available for grazing within eight weeks of sowing and can be utilized to provide grazing for the dairy herd, after the normal pasturage has lost it first freshness. Incidentally such newly-formed pastures are all the better for close-grazing. The alternatives to this procedure are to utilize special crops that are grown on the arable acreage.

Lucerne.

Over the greater part of England where deficiencies in grass production are likely to occur, lucerne is the most valuable of the supplementary crops. It is a matter of great surprise that it is not grown more extensively, because, once the crop is properly established, it provides stop-gap feeding merits at three seasons of the

summer, namely in early June for hay or soiling, in July for soiling and again in September. Its richness in protein, capacity for producing abundant bulk and its powers of resisting drought are sufficiently important to necessitate an expansion of the acreage on dairy farms. Even if it is not required for hay or soiling it converts satisfactorily into valuable silage for winter feeding needs. The cultivation of the crop requires weed-free land, good drainage, adequate lime content in the soil and good general initial fertility. Provided these conditions are satisfied, the only other precaution necessary for proper establishment is to sow up to 28 lb. seed per acre, preferably in drills, to allow for the eradication of weeds by harrowing, and for the seeds to be inoculated with the appropriate culture, which can be purchased from the seedsman. It is usually wise to sow the crop without a nurse-crop to give the best opportunity for establishment, and a cutting may be taken in the autumn of the sowing year, though the first cutting should not be made too close to the ground. The output of green crop per acre is about 15 tons per year and the crop will last for five to seven years, and when turned under for reversion to arable cultivation the productivity of the field in question will be greatly increased.

Triple-Purpose Crops.

Legume—Cereal Mixtures. These may be regarded as triple-purpose crops in the sense that they provide material for soiling and silage and can if necessary be allowed to mature for harvesting as grain. Of the cereals most commonly used, oats and wheat are the most popular on the basis of palatability, while of the legumes peas, beans and vetches form the chief selection. Beans are frequently incorporated in autumn seedings for the reason that they give better standing properties to crops that include vetches and winter oats. Autumn sown crops mature earlier than spring seedings, but it is important to choose winter-hardy varieties in the former case. Autumn-sown crops are ready in May and June and spring-sown crops in June and July. The seed rates generally utilized are 2 to 3 bushels oats with 1 to 1½ bushels of vetches or peas and ½ bushel of beans. A spring sown mixture of 2 to 3 bushels oats and 1 bushel of maple peas per acre makes very good hay, and if undersown with 14 lb. Italian rye-grass and 3 lb. trefoil provides good autumn grazing. The weight per acre of fodder crop grown in this way will average about 10 tons in the green state. These crops also fit satisfactorily into a sound scheme of rotational cropping, since when the ground is cleared before the end of July, a bastard fallowing can be given and this simplifies cleaning operations. It is also possible to catch-crop with another forage crop such as cabbage or kale when this is necessary. The use of rye and vetches was advocated at one time, but rye is only palatable for a short period and therefore its use is not recommended.

Brassicas. Spring-cabbages, such as Flower of Spring, planted in August are usually ready about the middle of May, and quick maturing varieties like Primus, planted in mid-April, are available at the end of July. Cabbages have a high feeding value for dairy cows and it is possible to clear about 15 tons per acre at this period of the year. Marrow stem kale which is normally regarded as a winter feeding stuff, can also be made available at the beginning of August by seeding in late March or early April.

Maize.

Over the greater part of England, with the possible exception of the six northern counties, maize can prove a valuable supplementary fodder crop in late August and September. It should be grown on clean, well-manured land, and therefore it can occupy a portion of the root-break. It is sown about the third week in May, when danger of late frosts are past; and it can be grown in drills, like root crops, and be subjected to inter-row tillage in its early stages to keep weeds under control. A seeding of 1½ bushels per acre produces an average crop of about 20 tons of forage that is much appreciated by cows. The chief drawback to its growth is that crows are apt to be destructive to the seed prior to germination, but stringing the area is usually an effective deterrent.

Crops for Autumn and Winter Feeding.

Hay.

Hay is the standby for the winter feeding of dairy cows where the best results are desired. Hay differs greatly in its feeding value, depending on the quality of the material from which it is made and the freedom from bad weather during the making process. There is a need for the wider recognition of the methods of making good hay, especially in respect of avoiding the effects of bad weather. There are two points in particular that prove helpful in this connection. The first is that the rate of drying is hastened by using a tedding machine to spread the hay as soon as it is mown and then putting it together in windrows in the event of rain. The second is the value of making cocks in uncertain weather. Mechanized methods of handling the crop have made it possible to take full advantage of good spells of fine weather. From the standpoint of initial quality, hay possessing a good proportion of leafy matter to flowering stems is of higher feeding value than when the crop is allowed to become too ripe. Greater care has to be taken in making such hay, for it is much more liable to heat in the stack unless it is properly cured. The use of 2 per cent of common salt mixed in with the hay is a useful means of checking over-heating in the stack, though it should be

emphasized that no risks should be run in stacking early cut or immature grass before it is adequately dried out. Even salt will not prevent such hay from firing in the stack, whereas it can be of help in the case of more mature material that is stacked on the green side.

From a feeding standpoint hay made from good old meadow grass is superior to the produce of one-year's seeds with a high content of red clover, due to its higher digestibility. The weight of produce per acre, however, is greater from the one-year leys, and in modern dairy farm cropping full advantage should be taken of the seeds break in the rotation of arable cropping. When long leys are being utilized as part of the dairy farming system, hay can be taken in the last year of the ley. It is better that it should not be taken in the first year, for the reason that a better pasture is established when the field is grazed in its first season. As yield of crop is important, it is desirable to recognize that a field intended to be set aside for hay should be given an adequate rest from grazing stock. Thus it is better not to graze such fields after the end of December. In this way you will usually find a crop of grass ready to mow in early June and be able to achieve the ideal of June hay. Such early-made hay will be of higher feeding value than that made in the following month. Quality is of more importance than quantity in the feeding of cows for high yields, though greater care is necessary when it is fed, to see that it is properly rationed.

The manurial policy for ensuring the production of good quality in satisfactory amount should be based upon the needs of the land. On farms that are mainly in grass, there is a tendency to utilize too much dung on meadows. This results in poor quality herbage, since farmyard manure is not a balanced manure, by reason of its relatively high concentration of nitrogen. A rotational system of manuring to satisfy the needs is therefore advisable somewhat on the following plan:—

- 1st year. Farmyard manure.
- 2nd year. Phosphates, potash and nitrogenous top-dressing.
- 3rd year. Ground lime or limestone and nitrogenous top-dressing.

The normal quantity of farmyard manure applied is from 10 to 14 tons per acre. Phosphatic fertilizers are usually applied in the form of basic slag at the rate of 5 to 7 cwt. per acre. On poor land the initial dressing may be increased to 10 cwt. per acre of high grade slag. Potash in the form of 2 to 3 cwt. of potash salts is advisable on the lighter types of soil. Other phosphatic and potassic manures may be utilized if desired, these being applied during the winter. Nitrogenous top-dressings applied in spring at the rate of 1½ cwt. per acre are particularly favourable to increased crop production when farmyard manure is not used. "Nitro-Chalk" or nitrate of soda can be recommended for this purpose. Where preferred the use of 3 to 4 cwt. of concentrated complete fertilizers may be substituted in the second year of the manurial programme, and, on meadows subject to flooding by rivers, the potash content of a complete fertilizer has given a satisfactory response in my own experience. Lime is as important on meadows as on pastures, and particularly when the importance of minerals is appreciated in the feeding of young stock and milk-producing cows. I have found it simpler to apply lime in the form of ground limestone at the rate of 25 to 30 cwt. per acre, from a manure distributor, rather than to apply a smaller quantity of burnt lump lime.

Long Leys.

In the case of long leys utilized for hay in the last year before ploughing up, a dressing of farmyard manure is very suitable for stimulating a good crop. The other manurial needs will generally be catered for during the course of arable cropping while the needs of lime phosphates and potash are usually supplied to the seed bed prior to re-seeding.

Where hay is utilized as the main maintenance diet, the maximum allowance per cow will be from 30 to 35 cwt. for the winter feeding period. This represents the produce of 1 to 1¼ acres of old meadow land or about ¾ acres of seeds land. It should be remembered, however, that winter forage crops, silage and oat straw are partial substitutes for hay and therefore the acreage necessary can be cut down where these alternatives are available.

Grass Drying.

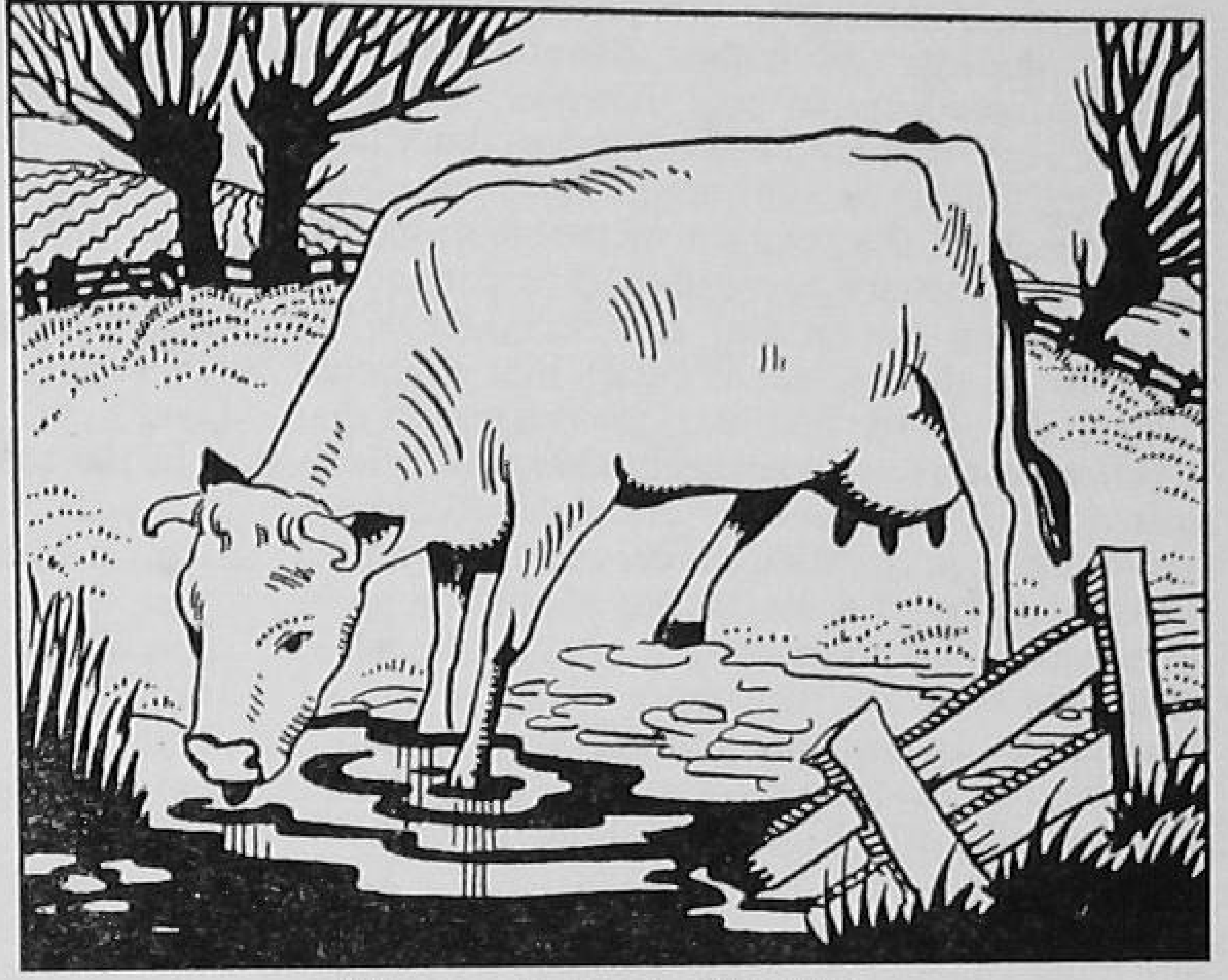
This is not properly a substitute for hay so much as a substitute for part of the concentrated ration. Good hay meets more than maintenance needs in dairy cow feeding, but owing to the uncertainty of weather conditions in differing seasons, there can be no guarantee of uniformity. Drying grass cut in the young stages of growth by artificial means does permit some control being exercised over quality. Grass drying is the ideal method of conserving the nutrients of grass, but unfortunately it is not a system that can be applied economically on a small dairy farm, on account of the relatively high cost of the plant required. Engineering skill may, however, develop cheaper plants for the small farm in due course, and when that time arrives the process will have much to commend it. It is an economical proposition on a large farm, but there again the commercial value of the dried product often means it is produced for sale to manufacturers of compound feeding stuffs, so that in this way buyers of such foods benefit from the good properties of the dried grass which impart a satisfactory colour to winter-produced milk because of the high carotene content of dried grass.

Silage.

Silage is a valuable foodstuff for winter, and it is produced from green grass, specially-grown legume-cereal mixtures, clover and lucerne and sugar beet-tops. It is made by carting the crop concerned, cut in the green state, to a silo, which may be a concrete or other container, a pit excavated in the ground or even a stack. The great advantage of the system is that it is independent of the weather and is therefore of particular value in those districts where weather conditions are uncertain, as in the western half of England. Silage also fits satisfactorily into the system of managing young grass leys, that tend to develop much growth in the early part of the season in excess of live-stock needs. The drawbacks of silage are represented by the inability of small farms to mechanize the process in the absence of plenty of labour, while there is also need for care in its making. On larger farms the availability of a Wilder Cutlift is of particular value, and on the farm of the Midland Agricultural College, silage-making in pits or clamps has proved the least wasteful method. The making process itself has been greatly simplified by the use of molasses; there is added to the green ensiled material 1½ gallons of molasses (mixed in an equal amount of water) per ton of green fodder put into the silo. The addition of the molasses aids fermentation, and this develops lactic and acetic acid, both of which ensure the satisfactory preservation of the silage. There are three main principles to remember in making good silage. The first is to allow the material placed in the silo each day to attain a temperature of up to 120° F. before adding further material; the second is subsequently to trample the silage adequately and the third is to seal the silo off to prevent the access of water and air. Silage will keep almost indefinitely, but the feeding quality of the silage bears a close relationship to the quality of the material ensiled. It is not customary to feed more than 30 to 40 lb. per head daily to mature cows and it is of particular value when cows go on to mangolds, since the silage balances the low protein content of the roots and also ensures a better coloured milk due to its carotene content.

Good Food.

Marrow Stem Kale. This is now one of the most widely grown crops for autumn and early feeding, the usual feeding period extending from October until the middle or end of January. Its virtues rest in the large amount of good food produced per acre, its ease of cultivation and its capacity for smothering rubbish. The crop is one which responds to liberal manurial treatment and especially nitrogen. Contrary to popular opinion the leaf is the most nutritious part of the plant, and my own custom is to sow the crop thinly, at from 3 to 4 lb. per acre, in 24-inch drills and not to thin out. In this way a heavier crop of superior



Water Supplies—Wrong.

Water Supplies—Right.

feeding value is grown than when singling is practised to develop very thick stems. Early sowing of the crop in April is an advantage in those districts where attacks of turnip flea beetle are common. Quantities up to 56 or 60 lb. daily can be fed to mature cows, but at the heavier amounts the milk is apt to carry a taint. Marrow Stem Kale is best fed to cows on pastures.

Thousand-headed Kale. This is more winter-hardy than marrow stem kale, and provides green food for the period from January to April. It is not always an asset however to be completely dependent on a crop occupying the ground after Christmas, owing to the weather problems which may arise from snow and frost.

Cabbages. These have a particular value from September to the end of December, and once the crop is grown, many dairy farmers prefer cabbages to kale on the grounds of easier cutting and less waste when fed to cattle. They have the same tendency as kale to produce taints in milk if they are fed in excessive amounts.

Sugar Beet Tops.

These are very suitable for feeding to milking cows in such restricted quantities as 20 to 30 lb. daily. Excessive quantities tend to produce a fishy taint in the milk, but otherwise beet tops are a very valuable substitute for marrow stem kale, and add to the attractiveness of sugar beet growing.

Mangolds.

As a source of digestible starchy material, this crop is unsurpassed, and is available from Christmas until cattle are turned out to grass. When crops of good keeping properties are grown, mangolds store until the early summer, and in this case are a valuable supplement to pastures affected by early summer droughts. Experience indicates that 40 to 45 lb. daily should be regarded as the maximum quantity to feed to cows in milk for the best results. It is generally considered an advantage to pulp the roots for feeding inside.

Swedes. In the north of England and Scotland where swedes give better cropping results than mangolds, these are used as a substitute and as a source of succulent food in winter.

Cereal Straws.

Of all the cereal straws, oat straw is the best, but its feeding value is greatest when the crop is cut on the green side. It can be utilized as a substitute for hay in the feeding of low yielding and dry cows, provided it is suitably balanced with other foods, and it can be used, in cases of hay shortage, to feed in addition to the hay. Modern practice favours the method of feeding in the long state instead of in the chaffed form. Barley straw can be substituted for oat straw and, though its analysis compares favourably with that of oat straw, it is not such a palatable fodder. Wheat straw, unless treated by the straw pulp process, is not a satisfactory fodder.

Home-Grown Grains.

Cereal Grains.

All the cereal grains may be utilized for dairy cattle feeding, oats being the most popular. Barley and wheat may also be utilized when they are crushed. A practice, which developed during the War, is to grow a dredge corn mixture, usually combining oats, barley and peas, harvested for the grain. It is customary to obtain a higher yield of grain per acre from a dredge corn crop than when only one cereal is grown.

Legume Grains.

Of the legume grains, beans and peas are grown with the object of attaining a greater measure of self-sufficiency. Both crops are uncertain, however, and it is never satisfactory to rely on one or other of these crops for meeting the major protein needs. Both beans and peas are highly satisfactory foods for production rations for dairy cows.

Linseed is a particularly valuable crop for meeting calf-rearing needs and over most of England the crop is a comparatively safe one.

Crop Rotations on the Dairy Farm.

System of Ley Farming.

In planning the system of cropping on the dairy farm there are two major points to remember. The first is the importance of good grass and good hay from the angle of cheapness of food production. The second is that taking the plough round the farm gives better grass, healthier grazing and makes possible the more effective utilization of fertility accumulations. Under ideal conditions therefore the system of ley farming is recommended, with no fixed ideal as to the length of time that leys remain down unless a fixed rotation is planned. Leys may remain down for three, four or more years if they continue to give satisfactory results; sooner or later they will have to be broken up to find fresh arable fields.

Of the cropping of the arable fields there can be no dogmatic laying down of requirements, beyond stating that the primary needs of the livestock carried by the farm must be met. Grain crops are required to give straw for fodder and litter for bedding as well as grain that can be utilized for stock-feeding. Roots are introduced for winter feeding needs and for providing a system of cultivations that maintains land in a satisfactory state of cleanliness. In some cases cash crops are grown on the root break, in addition to those required for home consumption. Such crops are potatoes and sugar beet. Under intensive farming conditions attempts are sometimes made to practise a system of cash-cropping on the root break to increase the output of food per acre, and the mechanization of arable

operations has presented the dairy farmer with increased opportunities. There is, however, no particular virtue in intensification of cropping if this cannot be pulled in with the existing labour. In the long run, land is cheaper than labour, and economical production may therefore be more readily achieved where the land available is adequate both for the needs of the herd, and for those of the other livestock on the farm.

Pasture Requirements.

Grazing Land.

The minimum acreage of crops needed to support the livestock carried must be calculated on a basis of average needs, having regard to the system of management to be followed and to the cropping capacity of the land. The acreage of grazing land is arrived at fairly easily by the following variations according to age:—

Age	*Description*	*Average acreage of grass per head*
6–12 months	Heifers	½
12–18 ,,	,,	⅗
18–24 ,,	,,	¾
	Mature beasts	1 to 1¼

It is customary to utilize the aftermaths of grassland mown for hay for grazing purposes and, in normal seasons, the grazing value of this will be from one-quarter to one-third that of land devoted entirely to grazing.

Hay Requirements.

Hay.

The acreage to be reserved for hay should be calculated in relation to the other home-grown supplementary foods that are likely to be available. Under ideal conditions it is desirable to budget for 25 cwt. hay per mature milking beast for the winter period, which would provide for 14 lb. daily for 200 days. The acreage required to produce this will vary with the quality and management of the land. Whereas old meadow land under proper management will produce 30 to 35 cwt. of hay to the acre, one-year's seeds leys will normally produce 50 cwt. per acre. One cannot guarantee that these yields will be obtained every season and for this reason it is a sound insurance always to carry a reasonable surplus of hay over from one year to the next, rather than to make a practice of buying hay in case of a shortage. Hay is also essential for calves, and one should budget for an allocation of from 5 to 6 cwt. to meet the needs of stock in the age group of 1–12 months old. Older heifers can receive straw and silage as part substitutes for hay, but an allowance of 10 cwt. per head should be adequate on mixed farms. On this basis the following acreages will be necessary for the provision of hay:—

	Meadow hay	*Seeds hay*
Mature cows	⅝ acre or	½ acre
Heifers 1–12 months	⅙ acre	
Older heifers		⅕ acre

Straw Requirements.

The Quantity Used.

Oat and barley straw can be utilized satisfactorily in the feeding of young dairy heifers, particularly those from 12 months of age up to the time that they enter the dairy herd. These will consume up to about 18 cwt. per head each, or the produce from ⅜ acre. Litter requirements have also to be met, usually from wheat straw. The quantity used depends on the system of management, and varies greatly in accordance with the quantity available. Mature cattle in sheds will require about 12½ cwt. each for the winter; and younger animals, in yards and boxes, will need from 8 to 12 cwt. each. It is often possible to buy wheat straw for litter purposes at an economical price, especially when the dairy farm does not possess an acreage sufficiently large to justify the growing of wheat.

Other Crops.

The root break is the pivot of most sound rotations, since it makes available food for winter-feeding and also is a means of maintaining the cleanliness of the arable land. The total weight of food nutrients produced by root crops exceeds that from any other source as illustrated in the following table:—

Crop per acre	*Dry Matter* cwt.	*Starch Equivalent* cwt.	*Protein Equivalent* cwt.
25 tons Marrow Stem Kale	70	45	6½
28 tons Mangolds	72	39	2¼
25 tons Swedes	57½	36½	3½
7 tons Beet Tops	22½	12½	1½
23 cwt. Beans	19¾	15	4½
20 cwt. Peas	17	13¾	3½
8 tons Tare and Oat Silage	45	20¾	4½
25 cwt. Oats }	21¾	14¾	2
25 cwt. Oat Straw }	21½	5½	⅛
23 cwt. Wheat	20	16½	2
10 cwt. Linseed	9¼	12	2
30 cwt. Meadow Hay	25¾	11½	1⅜
50 cwt. Seeds Hay	43	16½	2½
40 cwt. Lucerne Hay	32½	13¾	4¾
15 tons Lucerne (Green) 3 Cuts	66	31	9

It becomes necessary for ever dairy farmer to make approximate calculations of the acreage of ground to be devoted to crops for home consumption. Thus an average allocation of 40 lb. marrow stem kale per day per mature beast for four months feeding would require approximately 1 acre for every eleven cows. A similar allocation of mangolds would require 1 acre of ground for every 12 cows. In order to get a proportionate allocation of food for the young stock in the herd it can be assumed that:

1 mature cow=4 six months old animals
3 twelve months old animals
2 eighteen months old animals
1½ twenty-four months old animals
1⅓ thirty months old animals

It often happens that the whole of the root break on a mixed farm is not needed for crops for home-consumption. In this case the merits of sugar beet tops have to be considered as a partial substitute for kale, and particularly as there is an allocation of pulp to growers of this crop, which is a useful source of starchy food that can be employed as a substitute for oats. Where dairy farms are within reach of a sugar beet factory, beet is to be preferred to potatoes as a cash crop.

The Cereal Crops Needed.

Similar calculations should be made with regard to the cereal crops needed. Oats are more valuable than wheat on the dairy farm by reason of the value of the straw for feeding. One acre of oats will provide an allocation of 2 lb. of oats a day for four animals for twelve months.

As sources of protein, beans are widely grown, but they fail to prove as reliable a crop as silage in most years and in this connection lucerne is specially valuable.

The dairy farm of the future will be associated increasingly with ley-farming and the following rotation of crops is suggested as a guide:—

1st year—cereal crop.
2nd ,, —roots (kale, sugar beet, mangold, swedes).
3rd ,, —cereal crop.
4th ,, —seeds grazed.
5th ,, —do.
6th ,, —seeds (mown for hay and silage).

Root and Forage Crops all the Year Round.

The extent to which intensification of cropping output is affected by forage cropping on an all-the-year-round basis must be determined by local conditions, but the following table gives some idea of the possibilities:—

Crop	Time of sowing or planting	Period of feeding
Marrow Stem Kale	Successional sowing, starting beginning of April	September—January
Swedes & Turnips	May and June	September—January
Cabbages	Autumn and spring sown Drumheads	October—November
,,	Spring sown Savoys	December—April
Thousand-headed Kale	April—June	November—April
Mangolds	April	December—May
Italian rye grass	Summer and early autumn	April—May
Trifolium	Autumn	May—June
Tares, oats and beans	Autumn	May—July
Oats and peas	Spring	June—July
Maize	May	September
Lucerne	Specially sown area to remain down for several years	May, July, September

FEEDING FOR MILK-PRODUCTION

After a review of the common foodstuffs, Feeding-standards are considered with reference to (1) *Maintenance requirements,* (2) *Production requirements and* (3) *Dry-matter requirements. There follows a section on the Compounding of Rations. Winter-feeding is considered with mention of Maintenance needs and Production needs. Attention is given to the subject of Summer-feeding. The Section closes with notes on Water-supply and Feeding routine.*

Properly Fed.

As explained elsewhere, milk is derived from the blood supply of the cow, but the cow has first of all to utilize food in sufficient quantity and quality so that the requirements of high production may be satisfied. The cow on her part must possess the capacity for yielding milk when she is properly fed, for no amount of feeding by itself will produce milk in the absence of a cow with good secreting properties. To understand correct feeding it is necessary to know something of the composition of foods on the one hand, and the nutritional requirements of the cow on the other.

The common foodstuffs are broadly composed of the following ingredients:—

Feeding Stuff { Water; Dry Matter { Proteins, Oil, Carbohydrates (Starch, Sugar, etc.), Fibre, Minerals

Home-Grown Foods.

The common, home-grown foodstuffs are generally either watery foods like roots or bulky foods like hay and straw which are rich in carbohydrates and fibre. Proteins are a key ingredient in feeding stuffs, especially for the production of milk and lean flesh, but they are deficient in amount in most home-grown foods and are most simply provided in purchased concentrates derived from oil seeds. The exceptions in the home-grown foods are beans, peas, lucerne, clover, young grass, dried grass and silage made from legume mixtures. Not all proteins have the same feeding value, and it is considered sound policy to feed a variety of foods to ensure that a correct balance of these various proteins exists. Chemists have arrived at a means of comparing the protein content of different foods under the term " Protein Equivalent."

The oil content, carbohydrates and digestible fibre represent the food constituents that contribute respectively to the production of heat and mechanical energy, the production of animal fat, and the fat and sugar content in the milk. Foods with a preponderance of these ingredients and a minimum of protein are popularly termed " Starchy foods." Foods containing a high percentage of fibre, e.g. Straw, must be controlled in quantity when feeding high-producing cows, for the reason that too much energy is used up by the animal in endeavouring to digest it. The oil content of foods varies and it is now known that oils differ in the influence they exert on the fat percentage in the milk. The oil content of rice and maize meals and cod liver oil in excess tends to depress the yield of butter fat, whereas palm and cotton seed oil, butter and lard tend to increase the fat percentage. In feeding practice, a liberal oil allowance in the ration is of more significance for fattening animals and young stock reared under exposed conditions than for milch cows. The chief home-grown starchy foods are barley, oats, wheat and the root crops.

" Starch Equivalent."

The modern method of comparing the productive values of foods is by their " Starch Equivalent." This was devised by the German chemist, Kellner, who expressed the productive value of a foodstuff by its capacity to give a definite live weight increase in a fattening beast. In this country research workers at Cambridge have determined the actual productive values of many foods by live stock feeding experiments and though the system of comparison was concerned with the fattening qualities of foodstuffs, the values have been found to answer satisfactorily in dairy cow feeding. Actually the Starch Equivalent value includes the whole of the energy producing constituents like protein, fat, carbohydrates and fibre. The Starch Equivalent value of a food is a satisfactory guide for good buying since it is customary to study which food is going to give the best value and this is reached by comparing foods on the following basis:—

$$\frac{\text{Purchase price or cost of production per ton}}{\text{Starch Equivalent}} = \text{cost per unit of Starch Equiv.}$$

This is not a sound method of evaluating protein-rich food, however.

The mineral content of a food or combination of foods is now known to have an important influence on animal health, and much research work in recent years has been devoted to a study of the significance of minerals in animal feeding. The minerals which matter are lime and phosphoric acid, but there are others that have some importance, particularly where the natural herbage plants or the foods are deficient in what are termed minor elements. Minerals are necessary for the formation of bone, blood, and the digestive juices. Deficiencies are most commonly experienced in the diets fed to heavy yielding cows and to young stock. Unless the needs of these animals are met through the food, then the health, yielding properties and growth will suffer. With regard to health and yielding

WINTER FODDER.

bilities, the constitution of a good milk cow is now known to be associated closely with various glands in the body. Thus recent research at Reading suggests that milk output can be increased by feeding iodinated casein. This is related to the influence on thyroid activity, which stimulates heart action and metabolism. Good dairy cows generally have a more rapid heart beat than low yielders, which suggests natural thyroid activity. It has become customary to feed a mineral supplement to both dairy cows and young stock in the concentrated ration, as a routine practice, but the ideal is realized when the natural foods fed contain a sufficiency of minerals. This means the adequate manuring of grass and crops utilized for dairy cow feeding, and especially in maintaining the lime and phosphate content of the soil at a suitable level.

The moisture content of foods only assumes significance when making comparisons. Roots contain from 85–90 per cent of water; pasture and forage crops, 75–80 per cent; concentrates and meals, 10–14 per cent. A heavy diet of roots can be regarded as one means of supplying water to cattle.

Vitamins.

Biological research has demonstrated that natural foods contain minute quantities of substances called vitamins, and these are classified by letters—A, B, C, D, E, etc. The absence of essential vitamins leads to malnutrition and the development of certain diseases. In ordinary farm feeding practice vitamins A & D are of most significance. Vitamin A is associated with growth factors in the young animal and with disease-resistance. It is found in green plants, but cod liver oil is a good substitute in the absence of green food from the ration. It is concentrated in quantity in the colostrum of a newly calved cow and in the absence of colostrum young calves are more prone to scouring troubles resulting from the multiplication of *Bacillus coli* in the intestinal tract. Low calf mortality can be better assured by feeding dry cows in winter on some green food or by giving them as little as half a pound daily of dried grass to ensure adequate vitamin A content in their milk after calving. Vitamin D is associated with bone and teeth formation. It may be derived from cod liver oil, or by exposing the animal body to direct sunlight. Irradiation of certain foods is also possible for preparing Vitamin D.

Feeding Standards.

Scientists have evolved feeding standards which should be applied by the practical feeder if maximum efficiency is to be attained. These standards provide for the needs of maintenance and milk-production and indicate the amount of bulk or dry matter that animals of different weights can consume.

1. *Production requirements.*

Here we are concerned with the amount of food necessary to meet the needs of actual milk production and the allowance varies with the

quantity yielded and the quality of the milk. It also concerns feeding for fattening purposes and the development of the calf when the cow is pregnant. The following Table indicates the production standards per 10 lb. of milk.

Fat percentage of Milk	Starch Equiv. lb.	Protein Equiv. lb.
3·7 —3·8	2·50	0·60*
3·9 —4·0	2·60	0·63
4·2 —4·3	2·75	0·67
4·4 —4·5	2·87	0·70
4·7 —4·8	3·00	0·74
5·2 —5·3	3·25	0·81

2. *Maintenance requirements.*

This refers to the food needed by the animal to maintain itself in a healthy condition without varying in live weight or producing any milk. These requirements are expressed as 6 lb. of Starch equivalent containing 0·6 lb. protein equivalent per day per 1,000 lb. live weight. The following table indicates the variations necessary for cows of the various breeds in accordance with live-weight differences:—

Breed	Average live weight	Maintenance needs		Max. dry matter
		Starch equiv.	Protein equiv.	
	lb.	lb.	lb.	lb.
South Devon	1,450	7·6	0·86	39
British Friesian	1,300	7·1	0·77	34½
Dairy Shorthorn, Lincoln Red, Blue Albion	1,250	6·9	0·74	33
Welsh Black, Devon	1,150	6·6	0·68	30
Red Poll	1,100	6·4	0·65	28½
Ayrshire	1,000	6·0	0·60	27
Guernsey	950	5·8	0·57	24
Kerry	850	5·3	0·51	22
Jersey	800	5·1	0·48	21
Dexter	650	4·4	0·39	17½

Allocation of Dry Matter.

3. *Dry Matter Requirements.*

Ruminants need some bulky food for ruminating (chewing the cud), but there is a limit to the capacity of the digestive tract. The control of the bulk fed to high yielding dairy cows has led to greater efficiency with a higher milk output from cows with the capacity for high production. This important point was first stressed by Boutflour and is worthy of close attention by dairy farmers. Until the complete restoration of normal feeding conditions it may not be possible to attain the ideal in this respect owing to the bulky nature of most home-grown foods and a limitation in the supply of imported concentrated foods. The suggested maximum allocation of dry matter for the various breeds is given in the table of maintenance requirements. The average allowance is 3 lb. of dry matter for each cwt. of live weight, but some cows with large barrel capacity are able to exceed this amount. The fundamental secret of successful dairy cow feeding is to ration foods to the productive capacity of the cow and control the quantity of bulky foods fed by ensuring that access is given to the more digestible concentrated ration before the maintenance ration is fed. The feeding of cows is an individual matter, and both concentrates and bulky foods must be varied according to the actual yielding capacities. Rationing of any kind is impossible unless some knowledge obtains of the actual milk yields of each animal.

*Experiments at the Hannah Research Institute and Reading suggest that the above allowances of protein are too generous and for milk of 37–13·8 per cent of butter fat, 0·5 lb. of protein equivalent is recommended per gallon of milk produced. For the average cows of the country, this means the ratio of protein to starch equivalent should be 1 to 5 in the production ration.

Compounding of Rations.

The Maintenance Requirements.

In ordinary farming practice it is customary to standardize the maintenance requirements for all average yielding cows in the herd and then to feed a balanced production ration in the form of cakes, grain and meal at a given rate (usually 3½ lb.) per gallon of milk produced. Sometimes it is simpler when a good choice of home-grown foods is available to feed a common ration that covers the needs of maintenance and the first gallon of milk produced. Such a ration also satisfies the needs of in-calf cows. Whichever system is preferred, it is advisable to work out on paper the feeding standards needed and then to meet these with the appropriate quantities of foods available taking into account the different analyses of the foods. For this purpose it is helpful to have a ration ready-reckoner such as that prepared by Mackintosh, in Bulletin 42 of the Ministry of Agriculture and Fisheries on "The Feeding of Dairy Cows." The following list of the common foods is given as a guide to the composition, and adjustments can be made by multiplying or dividing the quantities according to the desired amounts.

Bulky Foods.

	Pounds of Food	Dry Matter lb.	Starch Equiv. lb.	Protein Equiv. lb.
Mangolds	10	1·22	0·63	0·04
Swedes	10	1·15	0·73	0·07
Turnips	10	0·85	0·44	0·04
Cabbage (Drum-head)	10	1·10	0·66	0·09
Do. (Polled)	10	1·53	0·95	0·15
Kale (Marrow Stem)	10	1·40	0·91	0·14
Do. (Thousand Head)	10	1·58	1·03	0·14

	Pounds of Food	Dry Matter lb.	Starch Equiv. lb.	Protein Equiv. lb.
Silage (Tares and Oats)	10	2·73	1·28	0·17
Do. (Grass)	10	1·94	0·79	0·12
Sugar Beet Tops	10	1·62	0·86	0·12
Maize (green)	10	1·94	0·91	0·08
Hay (Clover)	10	8·35	3·80	0·70
Do. (Lucerne)	10	8·40	2·90	1·18
Do. (Seeds)	10	8·60	2·90	0·49
Do. (very good meadow)	10	8·40	4·30	0·78
Do. (medium meadow)	10	8·57	3·70	0·46
Do. (poor meadow)	10	8·75	2·20	0·30
Straw (Oat)	10	8·60	2·26	0·07
Do. (Barley)	10	8·60	2·30	0·07
Do. (Pea)	10	8·60	1·71	0·36
Wheat cavings	10	8·60	2·62	0·11
Pasture grass (extensive grazing)	50	10·00	5·55	1·05
Pasture grass (close-grazed)	50	10·00	7·05	2·10
Lucerne (cut green)	20	4·80	1·86	0·52
Tares (cut green)	20	3·50	1·50	0·36
Brewers' grains (wet)	10	3·24	1·84	0·54
Concentrated Foods.				
Barley	1	0·85	0·71	0·07
Beans	1	0·86	0·66	0·20
Linseed	1	0·93	1·19	0·19
Maize	1	0·87	0·78	0·07
Oats	1	0·87	0·60	0·08
Peas	1	0·86	0·69	0·18
Wheat	1	0·87	0·72	0·10
Coconut Cake	1	0·89	0·77	0·16
Cotton Cake (Bombay)	1	0·88	0·40	0·15
Do. (Egyptian)	1	0·88	0·42	0·17
Do. (decorticated)	1	0·90	0·68	0·35
Ground Nut Cake (decorticated)	1	0·90	0·73	0·41
Do. (undecorticated)	1	0·90	0·57	0·27
Linseed Cake	1	0·89	0·74	0·25
Palm Kernel Cake	1	0·89	0·73	0·17
Palm Kernel Meal (extracted)	1	0·90	0·71	0·17
Soya Bean Cake	1	0·85	0·69	0·37
Do. Meal (extracted)	1	0·89	0·64	0·38
Fish Meal	1	0·87	0·59	0·53
Yeast (dried)	1	0·96	0·67	0·41
Brewers' Grains (dried)	1	0·90	0·48	0·13
Malt Culms	1	0·90	0·43	0·16
Flaked Maize	1	0·89	0·84	0·09
Maize Germ Meal	1	0·89	0·84	0·10
Maize Gluten Feed	1	0·90	0·76	0·19
Millers' Offals (Weatings)	1	0·87	0·49	0·12
Do. (Bran)	1	0·87	0·43	0·12
Rice Meal	1	0·91	0·72	0·07
Sugar Beet Pulp (dry)	1	0·90	0·61	0·05

Winter Feeding—Maintenance Needs.

Daily Requirements.

The maintenance needs of the dairy cow are usually met entirely from home-grown foods. Reference to the feeding standards shows that a Shorthorn cow needs 6·9 lb. Starch Equivalent and 0·74 lb. of Protein Equivalent. These daily requirements are approximately made up from the following:—

1. 19 lb. to 20 lb. medium meadow hay.
2. 12 lb. medium meadow hay and 40 lb. mangolds.
3. 12 lb. medium meadow hay and 25 lb. kale or cabbage.
4. 22 lb. tare and oat silage, 30 lb. mangolds, 7 lb. seeds hay.
5. 7 lb. seeds hay, 7 lb. oat straw, 40 lb. kale.

From many aspects good hay is the ideal maintenance diet for the dairy cow in full milk and actually this contains a reserve of protein for production purposes. Good meadow hay is more valuable as a milk-producing food than either clover or seeds hay, though the output of milk per acre of food grown is likely to be greater from clover and seeds. Straw is satisfactory for balancing out a shortage of hay, but should not be used in excessive quantities and never for high yielding cows. Oat or barley straw should be fed long, as in this way the cows are able to reject the more indigestible portions in the process of feeding. Hay cut on the young side, before it has gone to seed, and carried in good weather has much greater feeding value than mature or badly weathered hay, so that successful dairy farming requires attention being paid to cropping routine and management.

If one regards hay as the simplest diet and other foods have to be introduced, then approximate replacements can be made on the following basis:—

1 lb. of medium hay can be replaced by ½ lb. oats or dried beet pulp; 1¾ lb. oat or barley straw; 2 lb. young grass silage; 2½ lb. ordinary silage; 3⅛ lb. straw pulp; 3½ lb. kale or cabbage; 5 lb. roots.

Correct Dairy-Cow Feeding.

In making such replacements, it is essential to safeguard the protein equivalent in the ration, and to keep a careful watch on the bulk that is fed. Thus if 35 lb. of oat straw were substituted for 20 lb. hay, this would provide the Starch Equivalent necessary, but it would be seriously deficient in Protein Equivalent. Moreover the bulk of dry matter would be such that an animal asked to eat

a ration of this kind would have very little room for consuming any production concentrates. A reduction in the bulk of a maintenance ration can be effected when feeding very high yielding cows at the peak of production with a heavy production ration of concentrates. Thus a maintenance diet of 10 lb. medium hay and 5 lb. oats would give the animal 12·90 lb. of dry matter against the 17·14 lb. dry matter in the 20 lb. of hay which such a maintenance ration would replace. These are points of primary importance if the art of correct dairy-cow feeding is to be acquired, and it cannot be stressed too strongly that guesswork in feeding maintenance diets is as unsatisfactory as it is unscientific. The careful feeder is prepared to discriminate in the quantities and types of maintenance foods fed to the high and low yielding cows respectively.

Winter-Feeding—Production Needs.

A Balanced Ration.

As indicated in the table of production requirements, a Shorthorn cow yielding milk of about 3·7 per cent butter fat requires 2·5 lb. Starch Equivalent containing 0·5 lb. Protein Equivalent per 10 lb. of milk. (This is approximately 1 gallon of milk—actually 10·32 lb. = a gallon). This production requirement may be met by the simple method of feeding a balanced ration of grains, meals and oil-seed cakes that have a ratio of 1 part of Protein Equivalent to 5 parts of Starch Equivalent, fed in such amount as to satisfy the minimum protein needs per gallon of milk produced. Thus the simplest home-grown balanced ration is as follows:—

	Starch Equiv. lb.	Protein Equiv. lb.
2 lb. oats	1·20	0·15
2 lb. beans	1·32	0·40
Totals	2·52	0·55

It will be seen that this is very slightly in excess of the theoretical balance, but it is so close that for ordinary purposes one can feed 4 lb. of a mixture of oats and beans in equal parts by weight per gallon of milk produced.

A more complex mixture is the following, involving the use of purchased concentrates:—

	Starch Equiv. lb.	Protein Equiv. lb.
2 lb. oats	1·20	·16
2 lb. beet pulp	1·30	·10
1 lb. bran	·43	·10
1 lb. palm kernel cake	·75	·17
1 lb. linseed cake	·74	·25
½ lb. dec. ground nut cake	·36	·20
Totals	4·78	·98

By dividing the amount of Protein Equivalent into the Starch Equivalent in the above totals a ratio of 1 : 4·8 is arrived at, which is, for practical purposes, almost 1 : 5 which is the required ratio for a balanced ration. In order to ascertain the quantity of the above mixture to feed per gallon of milk, one arrives at the answer as follows:—

If ·98 lb. of Protein Equivalent are contained in 7½ lb. of mixture

Then ·10 lb. of Protein Equivalent are contained in $\frac{7\frac{1}{2}}{\cdot 98}$ lb. of mixture

Therefore ·50 lb. of Protein Equivalent are contained in $\frac{7\frac{1}{2}}{\cdot 98} \times \cdot 50$ lb. of mixture

$$\frac{7\cdot 5 \times \cdot 50}{\cdot 98} = \frac{375\cdot 0}{98} = 3\cdot 8 \text{ lb.}$$

This means that just under 4 lb. of the above mixture contain the necessary nutrients to feed for 1 gallon of milk.

Other production rations can be worked out in accordance with the supplies of foods available, but, as mentioned earlier, often it is customary to feed a maintenance diet that will also cover the needs of the first gallon of milk produced. Such an example is the following:—

	Starch Equiv.	Protein Equiv.
Theoretical requirements for a 1,250 lb. cow	6·9	·74
Theoretical requirements for a gallon of milk	2·5	·50
Total	9·4	1·24

Example 1.

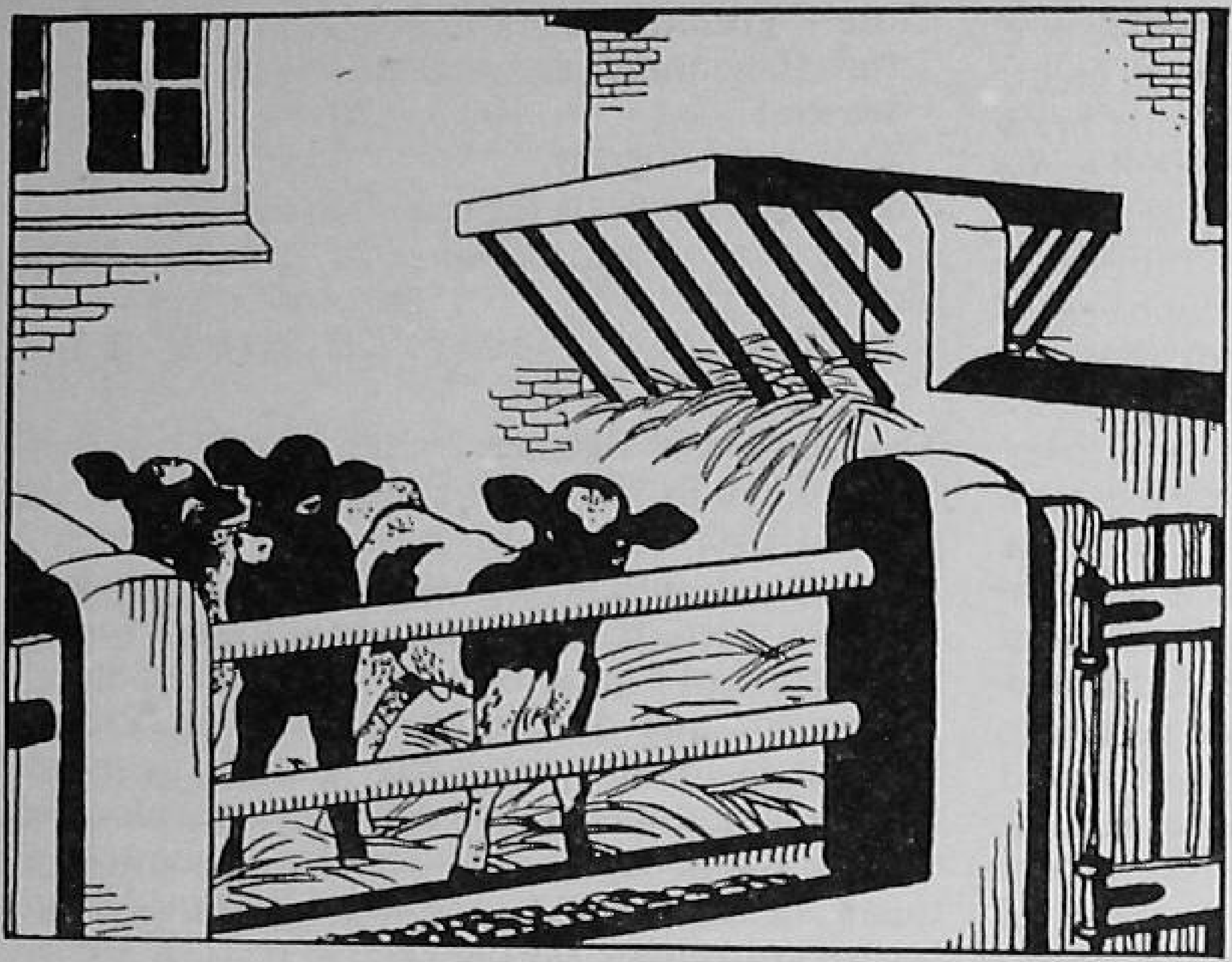
	Dry Matter lb.	Starch Equiv. lb.	Protein Equiv. lb.
12 lb. medium meadow hay	10·28	4·44	0·55
56 lb. kale	8·01	5·04	0·73
Totals	18·29	9·48	1·28

Example 2.

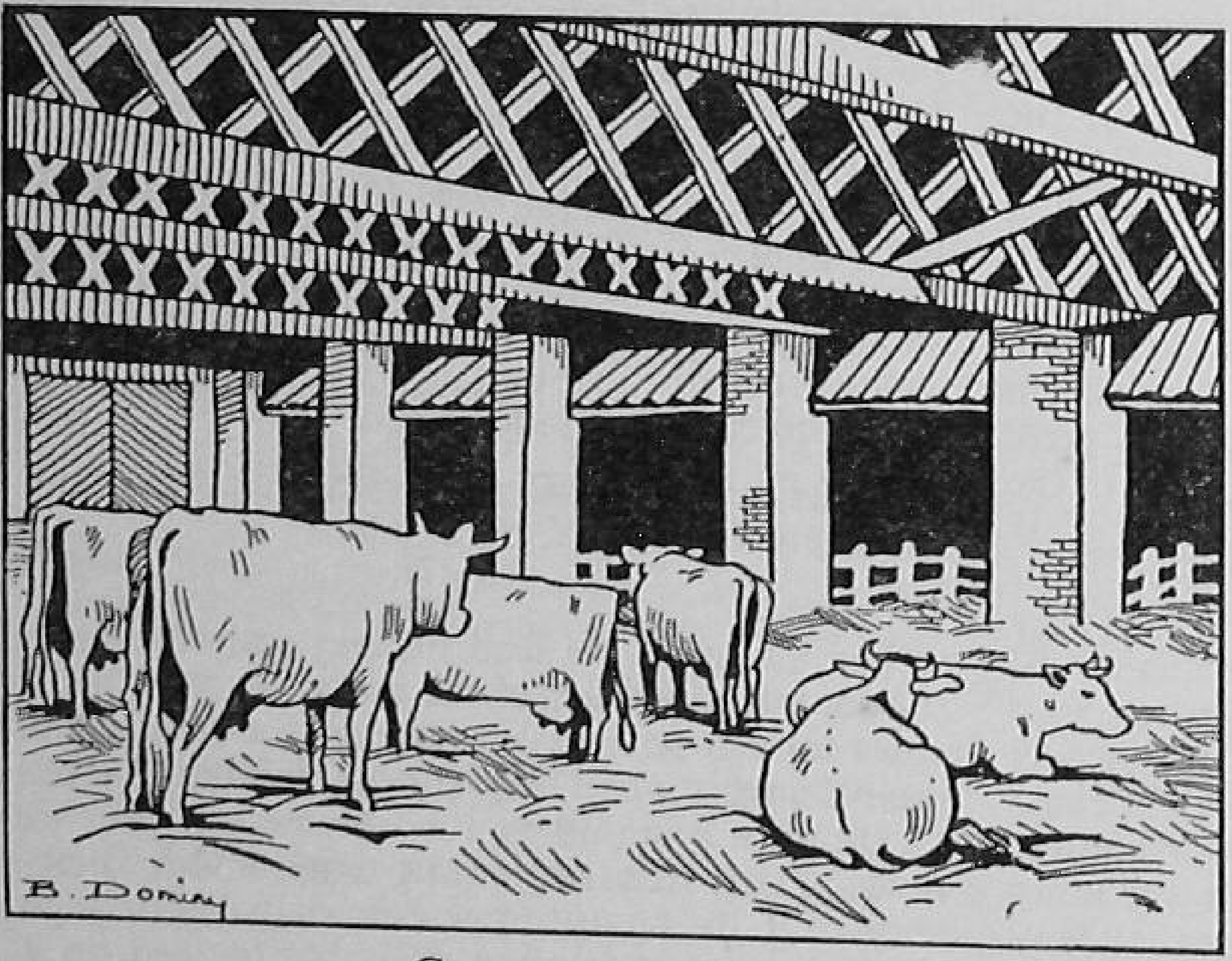
10 lb. very good meadow hay	8·40	4·80	0·78
15 lb. tare and oat silage	4·50	1·95	0·30
40 lb. mangolds	5·28	2·80	0·16
Totals	18·18	9·55	1·24

Good Palatability.

In the compounding of maintenance and production rations other factors besides composition have to be noted. Good palatability is important and succulent foods like roots and silage are useful in this respect. Some cows dislike certain meals, preferring foods in the cube or cake form. A variety of foods tends to improve the palatability and also gives better feeding results. As food costs are the greatest single item in the cost of producing a gallon of milk, it is important that home-grown foods should be grown as cheaply as possible per unit of Starch Equivalent and that purchased foods should be bought in the best market. To this end it is advisable to study the cost of purchased foods per unit of Starch Equivalent and, by purchasing those which give the best value on this basis, considerable economies can be effected in normal times when there is no limitation in the supply of food stuffs. Many food manufacturing and oil seed crushing firms have sought to solve farmers' feeding problems by marketing compound cakes, cubes or meals that are balanced for milk-production and other purposes. The great advantage of this service is that it eliminates home-mixing, thus saving labour; also it ensures that a properly balanced mixture is made available for the particular purpose for which it is required. For a farmer in a small way of business, buying a compound in this form ensures that he get small quantities of foods in fresh condition. When straight cakes are bought in too large quantities they may deteriorate through moulding under unsuitable storage conditions. Some compound manufacturing firms also mineralize the compounds and safeguard the vitamin contents. The great drawback to compounds is that they do not always fit in with the needs of the farm where home-grown starchy foods require to be balanced with high protein straight cakes, and a large-scale knowledgeable farmer can usually mix his own rations more cheaply than by using their equivalents in the form of compounds.



Comfort for Calves.



Comfort for Cows.

Guides to Success.

From the foregoing remarks it will be recognized that no sound system of feeding is possible unless the yields of each cow are known. This is one of the most important benefits of milk-recording. Once the exact yield is known then it follows that whereas a cow yielding 2 gallons of milk daily needs the maintenance allowance plus 7 to 8 lb. daily of a balanced production ration, a cow yielding 6 gallons of milk daily will need the maintenance allowance plus from 21 to 24 lb. daily of the balanced production ration. Also it must not be overlooked that heavy yielders must not be overloaded with a very bulky maintenance diet, so that a careful watch should be kept that the dry matter of the ration does not exceed the maximum capacity of the cow. There are two guides to successful winter feeding. The first is the absence

of grunting by the cow, which tends to indicate an overloaded digestive tract. The second is the condition of the bowels. Cows in good milk-producing health produce dung that is slightly laxative in character. Dung that is stiff should be the first warning that the feeding is wrong and such cows will not be milking to their best capacity. Digestive disturbances will be more easily avoided if a careful eye is kept on the consistency of the dung. The foods that tend to be naturally costive are straw, sweated hay, cotton cakes and bean meal. Foods that have a laxative effect are roots, bran mash, molasses, linseed cake, well-harvested early cut hay, and dried grass.

When home-mixing of production rations is practised, it is customary to mix up quantities of 5 to 10 cwt. at a time. It is important that the various ingredients should be thoroughly intermixed, usually by shovelling the material over and back again several times. As a safety measure it is also advisable to incorporate 2 to 3 lb. of a mineral mixture per cwt. of food, and a suitable one is 2 parts by weight of salt (dairy salt), 2 parts ground limestone and 1 part of sterilized steamed bone flour. An alternative is to provide rock salt in the mangers or in the fields and incorporate limestone and bone flour only in the concentrated ration.

Summer Feeding.

A Variable Material.

Good grass is regarded as the ideal as well as the cheapest food for a milk cow, but grass is a variable material depending on the season, the type of pasture and the management. Recent experience in the ploughing out and re-seeding of old pasture has indicated, markedly, an improvement in milk-producing output. Under normal pasture conditions the growth of young grass begins in April and the grass production during May and early June represents the peak from a quality standpoint. This is reflected in the jump in yields when cows are turned out to grass in spring. The milk-producing capacity of most pastures begins to decline by mid-June. This may be related to a deterioration in the quality of herbage due to the sending up of fibrous seed stems in the case of fields that were not closely grazed in May, or to the results of drought causing a cessation of young growth. Unfortunately it is not possible to determine with certainty the exact feeding value of a pasture at any particular time of year. Summer feeding therefore requires the exercise of good observation before determining the exact plan of feeding. The appearance of the cattle themselves and their maintenance of yield, or otherwise, must provide the real clues to good feeding practice. The usual thing that happens when cows are turned on to spring grass is that they scour (become loose in their bowel excretions). Formerly it was customary to check this by feeding some undecorticated cotton cake, which possesses astringent properties and undecorticated cotton is also fairly rich in protein.

Analysis of grass at various stages reveals the following composition:—

	Quantity lb.	Dry Matter lb.	Starch Equiv. lb.	Protein Equiv. lb.
Closely grazed pasture (beginning of season)	100	20	14·7	4·6
Do. subsequently grazed at 3-weekly intervals	100	20	14·6	3·4
Ordinary pasture—spring grazing	100	20	11·2	2·1

The Diet out of Balance.

If a 1,250 lb. cow consumes up to appetite, she will eat over 140 lb. of grass daily and even if running on ordinary pasture that is not kept closely grazed, the nutrients are sufficient for the production of 4 gallons of milk in terms of Starch Equivalent and 4½ gallons in terms of Protein Equivalent in May and early June. This means that feeding undecorticated cotton cake alone to counteract a laxative state of the bowels is throwing the diet out of balance and this is still further accentuated if the grass is recently seeded pasture or managed on the close-grazing and rotational system. It is thus obvious that the supplementary feeding of cows on grass in spring may be fibrous in character but should contain a low Protein and high Starch value. Cattle which scour are not able to derive the full food value from the grass, since this passes too quickly through the digestive system. A suitable balanced supplementary mixture for this period of the year should have a ratio of Protein to Starch Equivalent in the order of 1 to 7 or 8. An example of a ration conforming to this requirement is:—

1 part by weight of undecorticated cotton cake.
2 parts " " flaked maize
4 " " " oats.

The quantities to feed depend entirely on the productive capacities of the cows. In most herds cows have a small allowance of food placed in their mangers when they are running out to grass to simplify tying-up in the cowshed at milking times. This may necessitate a minimum allowance of 1 lb. mixture per cow daily. For high yielding cows it is often desirable to feed on a basis of the actual gallonage of milk produced. As most dairy cow pastures are capable of improvement by proper management and manuring, it may be assumed that most milk-producers will take full advantage of the various means of increasing the feeding value of their grassland. Hence the following table is suggested as an outline of what can be reasonably fed during May and June:—

Milk yield of cow gallons	Concentrates to feed May	June
1 to 2	2 lb.	1 lb.
3	3 lb.	2 lb.
4	3 lb.	3½ lb.
5	6½ lb.	7 lb.
6	10 lb.	10½ lb.

In many cases cows are given no concentrates at all, apart from the tying-up ration, until the middle of June, irrespective of the yield. This however may have to be varied in accordance with the evidence of declining milk yields or the conditions of the animals.

Towards the end of June, the quality of the grass deteriorates, but it becomes better balanced for milk producing purposes, and provided there is no shortage of grass, the grazing during July and August should suffice for the first 3 gallons of milk produced. Supplementary feeding provided for cows giving yields greater than this may conform to the balance provided in winter. It is customary in some parts, especially where arable crops are grown, to supplement the pasturage with cut forage crops, often called "Soiling" crops. Crops which come within this range are Trifolium and Italian rye-grass; tares and oats, or peas and oats; and later in the season maize, marrow stem kale and cabbage. Feeding values differ somewhat, but 25 lb. of cut forage will suffice for the production of a gallon of milk.

To urge economy in the use of concentrates, when cows have abundant good pasture, is natural, but economy in this respect is sometimes against the best interests of the cattle and the continued production of milk at a satisfactory level during the autumn and early winter. Again it should be emphasized that the yields and the body condition of the cows will provide the answer to the treatment that is necessary. Much of the interest in good herd management centres on one's capacity for anticipating needs.

Hours of Grazing.

At the beginning of the grazing season it is desirable to restrict the hours of grazing if cattle are turned out onto fresh pasture. Too often the herd of cows is turned onto a fresh pasture, allowed to consume to appetite and then to lie down, dung and urinate; in this way there is waste of an appreciable area of grazing land. An hour two of controlled grazing after each milking followed by removal to a bare pasture will make the grazing go further. Similarly, if the arrangement of the pasture fields, say five in number, is such that one field after another can be grazed in rotation and rested after being grazed down, the output of grass will be much greater than if cows are given access to one large area. Electric fencing can be used effectively for sub-dividing existing large areas, and this form of cheap fencing can prove to be a great boon to dairy farmers. One has to recognize that the lay-out of many dairy farms is far from ideal, but it is often worth taking trouble to sub-divide the night pasture, which is usually the one nearest home, so that it is more thoroughly grazed on a rotational basis and that the droppings are more evenly spread over the entire field.

Nitrogenous Top-Dressings.

The productiveness of grass during the grazing season can be materially increased by the use of nitrogenous top-dressings, and these are often employed to stimulate an earlier bite of grass at the beginning of the grazing season, and also to lengthen the grazing season in the autumn. Thus an application of 1 to 1½ cwt. per acre of "Nitro Chalk" can be given in February or early March for early bite requirements and a similar dressing applied during a rainy period in July will do much to revive flagging pastures.

Water.

An abundant supply of pure water is necessary for a milk-producing farm. At least 3 to 4 gallons of water are required by cows per gallon of milk produced. The installation of drinking bowls in cowsheds has not only been responsible for an increase in the output of milk, but has also ensured greater freedom from digestive troubles and has resulted in improved health.

Feeding Routine.

The order of feeding is important and the following points should be observed.

1. Concentrates are to be fed just before the morning and afternoon milking. In some cases cows will not let down their milk if they have been accustomed to receiving concentrates during the milking process. There is no particular objection to this if it is found to be necessary, and it is a more or less universal custom.
2. Foods that may taint the milk should be given after milking; these include roots, especially swedes, cabbage, kale, sugar beet tops.
3. Never feed hay or straw before or during milking, owing to the danger of filling the atmosphere with dust. These foods should be fed after the roots.

COSTS OF MILK-PRODUCTION

The methods of investigation are explained and some comparisons are made. The influence of Autumn-calving upon the financial returns is given consideration and the influence of other activities upon milk-costs is examined.

Costs of Milk-Production.

SINCE 1934 the Milk Marketing Board has sponsored a scheme for the collection of the costs of milk-production, and reports on the results year by year are issued by the Agricultural Economics Research Institute, Oxford. Many factors influence the cost of milk-production, and it is in the best interests of milk-producers to study carefully the data that have been collected from representative milk-producing herds in different parts of the country. It is not sufficient to know that milk-production provides one with a steady income. What is of importance is to know how to improve efficiency so as to reduce costs of production in order to enjoy a better livelihood. Hitherto few milk-producers have had definite figures as to actual costs and no real progress is possible unless each individual producer is in a position to compare his own figures with those obtained by other efficient milk-producers. Furthermore the more importance milk assumes in the general dietary of the nation, the greater the need for ensuring efficient and economical production, not forgetting the necessity for providing a good livelihood for those responsible for its production. With the wider collection of information relating to costs of production, it may be assumed that producers' interests will be safeguarded better in the direction of price fixation. This, however, will not be a lever to allow the inefficient to continue to produce on equal terms with those whose efficiency is beyond question. In a competitive world efficiency must be the standard by which results are judged, but wide allowances have to be made in farming costs by reason of the variations in seasons and the effects of these upon economical production of home-grown foods. Small as this country is, there are, nevertheless, marked variations in climatic factors between one part of the country and another, and these are important points to be considered in the price structure of costs in relation to milk production.

As an illustration of this, a cold spring followed by a dry summer not only affects the abundance of grass for summer milk, but also the yield of hay for winter milk. Seasons are not constant and, in consequence, the dairy farmer has to be prepared for the unexpected in his general planning of cropping. The following figures, representative of the costs of milk-production, indicate the importance of foods in relation to other costs:—

Comparisons of Costs of Milk Production in the East Midlands for the years 1938–39 *and* 1943–44 (in pence per gallon).

	1938–39	1943–44
Foods:—Purchased	3·36	3·04
Home-grown	1·60	6·77
Grazing	0·84	1·21
Total Foods	5·80	11·02
Labour	2·34	4·67
Miscellaneous	1·07	1·80
Herd Replacement	0·96	0·93
Gross Farm Costs	10·17	18·42
Credits:—Calves	0·63	0·69
Manurial residues	0·38	0·41
Net Farm Costs	9·16	17·32
Net Farm Returns	13·50	24·27
Surplus	4·34	6·95
Average yield per cow in gallons	635	581
Surplus per cow	£11 10s. 0d.	£16 16s. 7d.

(It should be noted that the above figures do not include any charge for the cost of management by the farmer or for interest on the capital invested in the milk-production enterprise).

There was relatively little difference in the costs of food in relation to the total cost of milk production during the War by contrast with pre-war figures, but at 60 per cent of the total cost it is by far the most important single item. Any sharp rise in food prices affects materially the cost of milk production and there is scope for a careful scrutiny of feeding methods to achieve the greatest efficiency.

Labour costs advanced during the years 1939–45 and these in general are reflected in an increase of over 2d. per gallon between 1939 and 1944.

The figure of nearly 1d. per gallon for herd replacement charges depends on such factors as the difference between the cost of rearing heifers or buying-in animals to replace cows leaving the herd for disease, low production or old age, and it takes into account the prices realized for cows sold out of the herd in a fat or store condition. A high buying-in price and a low beef price for cows sold out mean a heavier depreciation charge and therefore a higher cost for herd replacements. On the average a cow remains in the milking herd for just under 3 years.

Individual Factors.

In considering individual factors in relation to milk-production costs, the figures collected by the Agricultural Economics Research Institute

suggest that slightly lower costs of production are attained in herds with over 30 cows. It is not suggested that this fact should rule out milk-production in smaller herds, since three out of every four farms in this country are under 100 acres in area and milk-production is by far the most attractive interest on the majority of these holdings. By reason of the greater degree of personal attention give to the enterprise efficiency is often of a very high order on the smaller farms.

Labour costs and the difficulties of obtaining an abundance of skilled hand-milkers have led to a large increase in machine milking. Up to September, 1939, the evidence of costings figures indicated that the net farm cost of milk-production was slightly higher in machine-milked herds; this was due to the fact that machine-milked herds tend to have slightly lower yields per cow, while herd replacement costs are higher. The marked increase in labour costs since 1939 however has changed this, so that the present advantage in favour of machine-milking is in the region of ¾d. a gallon.

One of the most important factors in lowering the cost of milk-production or, conversely, of increasing the profits from dairy farming concerns a high average yield per cow. This is a problem that is linked closely with a progressive policy of good selection of milking animals, and good breeding, feeding and general management. Equally important is the elimination of diseases that shorten the life of the milking cow.

Influence of Autumn Calving on Financial Returns.

During the war it was necessary to concentrate attention on the production of as much milk as possible during the winter months. To this end more favourable prices obtained for milk produced in winter as the following figures indicate:—

1949.
April 2/4; May 1/9½; June 1/9¼; July 1/11½; August 2/3½; September 2/6; October 2/11; November 3/3¼; December 3/4¾.

1950.
January 3/4¼; February 3/2¼; March 2/10½.

If one assumes an average yield of 540 gallons per cow which was a common war-time average in commercial herds and is so at the present time, this provides for the cow giving an average production of 3 gallons a day for the first three months after calving, 2 gallons a day for the following three months and 1 gallon a day for the last three months of the lactation. The gross returns per cow per year at present prices compare as follows with different calving dates:—

Calving date	Gross income from milk per cow
October 1st	£80
December 1st	£75
February 1st	£66
April 1st	£62
June 1st	£69
August 1st	£78

The financial inducement to have cows calving from August to December is clearly emphasized in the above figures, though it has to be recognized that feeding and labour costs are higher in winter than in summer. Winter milk production however utilizes and retains labour that is needed for crop production during the summer period, so that this additional factor must not be overlooked. There are other advantages resulting from Autumn calvings and particularly a higher lactation yield per cow, while the cow will be dry at a time she is running on grass and therefore is better fitted for a good following lactation by reason of proper feeding. Against this the risks of mastitis, especially "August bag" have to be considered in some parts. It is obvious however that the attainment of level production all the year round requires cows to calve on a regular basis, but an attempt should be made to have the fewest animals calving in the spring months.

Influence of other Activities on Milk Costs.

The Oxford Institute of Agricultural Economics in an analysis comparing a group of low cost milk-producing farms with a group of high-cost farms for the three years 1935–1938 provided an interesting contrast in the various livestock activities undertaken. These are set out below:—

	Stock carried per 100 acres Low cost	High cost
Cows	15·2	21·8
Other dairy cattle	12·2	4·7
Other cattle	4·4	3·9
Sheep	51·5	37·0
Pigs	9·5	9·4
Poultry	165·8	181·7
Horses	2·4	2·4

Sheep.
These figures reveal that the low cost farms were less intensively stocked with dairy cows, but a more active home-rearing policy was pursued. They also carried a higher sheep population, which is interesting if only for the fact that many dairy farmers think sheep out of place with cows on the grounds that they take valuable grazing. Taking the long view it is sound practice to associate dairy farming with an active breeding policy, with the object of breeding one's own replacements, rather than to stock intensively with cattle that are in milk and thus to be depen-

dent on the purchase of regular replacements.

Extravagance in the use of purchased feeding stuffs was a common pre-war error on farms returning high costs of milk-production per gallon. Under conditions of war-time rationing it was still possible to be extravagant in the use of home-grown foods, particularly if these were not adequately balanced in respect of the ratio of proteins to carbohydrates. This point must be borne in mind today.

Efficient production in relation to low costs can best be secured by:—

(*a*) Keeping productive milch cows that maintain a good average yield each year.

(*b*) Breeding a sufficient number of selected home-bred heifers for the purpose of herd replacements.

(*c*) Growing productive crops to economize in feeding and to ensure the best ultilization of labour.

REARING OF CALVES AND YOUNG STOCK

An important subject is now dealt with, under the following heads:—Calf Rearing; Methods of Rearing; Pasture for Calves; Dishorning Calves; Ear-marking Calves; Rearing from six months onwards.

Calf-Rearing.

The heavy yielding milk cow is a hard-worked animal and to this end her frame should be equal to the strain imposed upon her. This means that she should be properly reared from calfhood, the first six months of life being particularly important. This is not to suggest that young animals should be kept in a condition of fatness, but rather that the frame should be adequately developed and nourished. The general impression that cattle stocks have deteriorated needs examination from the nutritional aspect. Milk-selling farmers have been tempted to sell as much milk as possible off the farm and to rear young calves on milk substitutes. It is often suggested that the deterioration in the quality of store cattle is due to the use of dairy-bred bulls. While this may be partly true, in most store-cattle breeding districts there has been a change-over from butter-making to milk-selling. No longer are there the quantities of skim milk available for calf-rearing and there are good reasons for believing that this has had an unfortunate influence on the type of animal that reaches maturity. No live stock improvement scheme will ever achieve the maximum benefit unless it is linked with a method of calf-rearing to provide the best foundations for the later life of the animal. Since good rearing is essential for the best results it is important to retain heifer calves out of the best cows rather than to waste good food on the progeny of nondescript animals.

Opinion is divided as to whether the calf should be removed from its mother as soon as born, or allowed to remain for a period of three or four days. Immediate removal is desirable if there is any doubt as to the healthiness of the mother, and there is also the advantage that cow and calf both settle down more readily if this course is adopted. In this case the calf should be well rubbed to dry it after birth, either with straw or clean sacking and placed in a clean, dry calf pen, and should always receive its own mother's milk for the first three or four days. When the calf remains with the mother, it will tend to get on to its feet sooner, since the cow licks her own calf dry, while there is reason to believe that the calf relieves the udder of the cow more soothingly than hand-milking. It is advisable that the cow's teats should be washed prior to the calf suckling if possible, and one should see that all the quarters are uniformly suckled.

The Colostrum.

For the first three days after calving the milk differs materially in chemical composition from normal milk and is called "colostrum" or "biestings"; it is of a deep yellow colour, has a salty, pungent taste, with a purgative effect on the calf. The colostrum contains certain biological properties of a protective character against disease-forming organisms in the intestinal tract of the calf. Hence it is important that the calf should receive this milk. When a calf has lost its mother at birth, the following substitute for colostrum can be given:—whip up an egg with half a pint of warm water, add half a teaspoonful of castor oil and stir in one pint of new milk. This is sufficient for one meal, and should be fed at body temperature and given for the first three days of life.

A further routine practice is the dressing of the navel cord to restrict germ infection. Materials commonly employed are tincture of iodine or powdered copper sulphate.

Methods of Rearing.

Calf-Rearing.

Milk is still the ideal food for calf-rearing and there is no substitute to compare with it if live-weight gains and healthiness are an index of feeding efficiency. The heifer calf however is not to be treated as a fattening animal, but this does not diminish the importance of milk as a basic part of the diet of a dairy heifer calf. Milk contains the ingredients necessary for good progress, in a readily digestible form. It is desirable that calves should be reared according to a definite feeding plan and the first point to settle concerns the allocation of whole milk. Whatever system of rearing is adopted subsequently, it is wiser to feed milk at least for the first month of the young calf's life, and thereafter milk should not be withdrawn completely for a further four weeks.

The newly-born calf will drink about three pints of its mother's milk twice daily for the first week. The milk should be fed at blood heat and the addition of a little warm water may be made if the calf seems thirsty. After the first week the milk may be increased to one gallon a day, fed morning and evening. It is always better, in order to avoid digestive troubles, to keep a young calf slightly hungry, rather than to feed to appetite. If the milk is known to be rich in butter fat, dilution with water is always advisable. Some feeders take the precaution of adding a cupful of warmed lime-water at each feed for the first months. Other points to emphasize are the necessity for feeding at regular intervals and of keeping the feeding buckets scrupulously clean to avoid digestive troubles. When a change to another system of feeding is contemplated the new-milk allowance should be withdrawn gradually.

Milk-Substitutes.

The subsequent method of feeding on most milk-selling farms is by means of milk-substitutes. It is not possible to prepare a milk substitute that is as efficient as whole milk, but a number of proprietary preparations are on the market for mixing with boiling water to feed as gruel. The best of these milk-substitutes contain dried separated milk, dried whey, dried yeast, linseed meal, oat meal and maize meal. During the War, National Calf Starter gruel has been evolved, and has been used successfully where those feeding calves have been prepared to use commonsense in individual feeding rather than treating the animals as machines for the consumption of food. It is always important to adhere carefully to the mixing instructions issued with the various calf-foods available. Thus when such mixtures contain linseed meal it is essential that the gruel be mixed with boiling water, otherwise there is a danger of small amounts of prussic acid being developed and this is, of course, poisonous. No danger arises from this if linseed is fed in the dry form.

The use of dry foods as milk substitutes has been followed by the writer very successfully for many years at the Midland Agricultural College. This is found to avoid many of the common digestive ailments, is less trouble to prepare and feed than gruels, while less time is taken up in cleaning buckets. Typical mixtures are as follows:—

1. 40 per cent (by weight) crushed oats; 20 per cent flaked maize; 30 per cent broken linseed cake; 10 per cent white fish meal.
2. 50 per cent crushed oats; 10 per cent bran; 30 per cent linseed cake; 20 per cent white fish meal.
3. 30 per cent crushed oats; 30 per cent rolled barley or yellow maize meal; 10 per cent bran; 10 per cent linseed meal; 20 per cent dried separated milk.
4. Equal parts oats and beans.

The addition of cod liver oil to all meal mixtures for calves is advisable and in order that the oil should not lose its vitamin A potency, it is better that it be added to the food each day at the rate of 2 teaspoonfuls per calf per day.

Where fish meal is being fed the mineral balance is usually satisfactory. It is an advantage to provide rock salt in the mangers, but a general mineral mixture is advisable in districts where home-grown foods are deficient in natural minerals. A suitable mineral mixture is equal parts of sterilized steamed bone flour, ground limestone and common salt, mixed at the rate of 1½ lb. per 100 lb. of concentrates.

As calves begin to chew their cud at from 2 to 4 weeks old the supply of a small allowance of hay becomes necessary. Early cut meadow hay is the ideal as this is not too fibrous. Clover hay should be avoided until the calf is six months old. The quantity of hay fed should be progressively increased but should be fed sparingly at first and what is left should be removed and replaced by fresh hay.

Cut roots such as swedes or mangolds may be introduced after the age of two months and be fed at the rate of up to 5 lb. daily. Silage is not very suitable until calves are three months old, and then the feeding of mouldy or frozen material should be avoided. A suitable quantity for calves is from 1 to 2 lb. daily.

The following feeding programme will serve as a guide to good rearing practice:—

Age of calf	Quantity to feed
First week	New Milk—3 quarts daily in two feeds + water
Second and Third week	,, ,, —4 quarts daily in two feeds
Fourth week	,, ,, —do. + ¼ lb. milk substitute + hay
Fifth week	,, ,, —do. + ½ lb. do. + hay
Sixth week	,, ,, —3 qts. + ⅔ lb. do. + hay
Seventh week	,, ,, —do. + ¾ lb. do. + hay
Eighth week	,, ,, —2 qts. + 1 lb. milk substitute + hay
Ninth week	,, ,, —do. + 1¼ lb. do. + hay
Tenth week	,, ,, —1 qt. + 1½ lb. do. + hay
Eleventh week	,, ,, —do. do. do. + hay
Twelfth week	Meal mixture at rate of 1½ lb. or more per day increased gradually as calf gets older. At 14 weeks the quantity consumed will average 2¼ to 2½ lb., and reach an average of 4 lb. daily by 20 weeks.

As the amount of liquid in the form of milk is reduced, access to water should be allowed. Water bowls are quite satisfactory in calf pens, and there is no truth in the suggestion that unrestricted access to water causes "pot-bellied" calves. This is more likely to arise when calves reared on gruel are given too much water with their gruel.

The above feeding programme utilizes just over 47 gallons of new milk; about 3½ cwt. milk substitute concentrates and 4½ cwt. hay, during the first six months.

Suckling Method.

Occasionally on milk-selling farms, a cow or heifer that is suffering from mastitis or has lost a quarter or possesses some other defect which interferes with normal milking having, for example, short teats or being a hard milker—is utilized for rearing calves by the suckling method.

PROTECTION FOR MILK CHURNS.

Where this system is followed it is possible to rear up to six, or even more, calves per cow or heifer, depending on the milking propensities of the foster mothers. The routine in this case is to allow the first pair of calves to suckle for 10 weeks, when they are replaced by a second pair for 12 weeks; finally a further pair is placed on the cow until she is dry. Patience is necessary in some cases until the foster mother becomes used to the calves. The cow may have to be tied up by the neck as well as the hind legs to give the calves an opportunity to suckle without being kicked. Meal mixtures and hay are fed in addition as soon as the calves are old enough, so that they are independent of new-milk when removed from the foster mother.

Once the calf has been launched successfully on its career—and this usually takes place during the first six months of life—there will be little need for worry thereafter. The bad effects of a poor upbringing during the first six months of life cannot easily be rectified by liberality of subsequent feeding. A properly reared calf is better able to rough it when required to do so in later life. Calf-rearing is a very personal matter and no part of the dairy farmer's activities demands more attention to detail. The calf is as important as the milking cow, and cleanliness and regularity in management and feeding are equally necessary. Kindliness and patience are just as important, especially when teaching calves to drink from a bucket, while variety in diet is one of the secrets of successful rearing. A good calf possesses a well-grown frame, a clean shiny coat, a straight back and no evidence of a blown out or dropped belly. Under good artificial methods of rearing, a daily gain in live-weight of 1¼ lb. or 9 lb. per week can be expected with most breeds of calves.

PASTURE FOR CALVES.

Grazing.

Experience indicates that calves born after the end of May are best kept indoors until the following spring. In the case of calves old enough to be allowed out, grazing should be restricted to clean pasture, where they will not associate with older cattle. This is a safeguard from a health point of view, though there is no reason why calf pastures should not be grazed with horses or sheep. The great objection to turning young calves on to grass in late summer is the risk of husk infection, though this need not arise if freshly seeded leys are utilized. Calves that are kept inside during the summer should receive a small allowance of cod liver oil to make good any deficiencies in vitamins A and D. Under outdoor conditions the first is derived from green grass and the latter from direct sunshine. Calves running outside should be housed at night from the end of August and should not be turned out in the morning until the dew is off the grass.

This is a safeguard against husk infection.

It is possible to obtain satisfactory results from feeding cut green forage to calves kept indoors in summer and suitable cut forage can be obtained from young leys or lucerne mixtures.

Dishorning Calves.

Dishorning.

In commercial herds, where breed society requirements are not affected, the practice of dishorning should be considered favourably, and particularly where dual-purpose cattle are kept and the bull calves are reared for store purposes. Such animals make more money than horned cattle, and in so far as female stock reared for the dairy herd are concerned, these suffer less injury and thrive better when the herd is dishorned. The operation is simple. The calf is firmly held and the hair is clipped away from the tips of the horn buds. A stick of caustic potash (wrapped round with brown paper to protect the hands) is then moistened with water at the end and rubbed firmly on the point of each horn bud until the horn is made reddish. Two days later a further slight rubbing with caustic potash ensures the success of the operation. Dishorning should be practised between the 2nd and 7th days of the calf's life. Caustic potash sticks are obtainable from the chemist, and should be stored in an airtight bottle with a glass lid. Care should be taken not to rub caustic potash on the flesh of the calf, otherwise burning results.

Ear-Marking Calves.

Tattooed Numbers.

For the purposes of identifying cattle in pedigree and other herds, the system of using tattooed numbers in the ears is widely followed for pedigree and milk-recorded cattle, while in the case of bulls approved by the livestock officer a Crown is tattooed in the ear. Most breed societies require ear-marking to be done before the calf is a month old. In the case of pedigree Friesian calves, the breed society requires the submission of a card reproducing the approximate extent of the colour markings for purposes of identification.

Rearing from Six Months Onwards.

Rearing of Good Dairy Heifers.

There is no mystery attaching to the rearing of good dairy heifers if some sound knowledge obtains regarding the feeding standards necessary for proper nutrition. Between the ages of six months and a short time before the heifers enter the milking herd the feeding should continue to be adequate for growth rather than fatness. A satisfactory average gain in live weight for dairy heifers is about 1 lb. per day and the following table outlines the theoretical standards for dairy heifers:—

Age	Live-weight	Dry Matter	Starch Equiv.	Protein Equiv.
3 months	1¾ cwt.	4·9 lb.	4·20 lb.	0·75 lb.
6 „	3 „	8·4 „	5·20 „	0·72 „
12 „	4¾ „	13·0 „	6·12 „	0·70 „
18 „	6½ „	18·2 „	7·00 „	0·83 „
24 „	8 „	22·4 „	8·00 „	0·93 „
30 „	9 „	25·2 „	8·50 „	1·00 „

The successful stock-rearer studies the condition of the animals in addition to satisfying theoretical standards and powers of observation should always be utilized to the full in making any feeding adjustments that may be necessary.

Points of practical importance include keeping heifers in uniform-sized groups to prevent small animals being bullied by larger animals. In summer, yearlings and two-year olds derive sufficient nutrients from pasture land, so that no supplementary feeding is necessary. Preference should be given to grazing on young leys, and it is sometimes advisable to counteract the high protein content of grass by a small allowance of dry starchy food such as crushed oats for the first few weeks after turning out. In winter, hay and roots can be regarded as the basic diet. If hay is in short supply, a partial substitution of oat or barley straw may be made. Wheat straw is not suitable unless it has been treated by the caustic soda (straw pulp) process, when its feeding value is very considerably enhanced. Silage is a very valuable winter food and a partial substitute for protein concentrates. Pulped kale is a popular substitute for roots, and is fed at half the normal rate for roots. Concentrates should always be limited in quantity and, provided adequate quantities of good quality roughages are fed, it is rarely necessary to feed more than 2 lb. of grain or concentrates per head per day.

The following rations are typical of good winter feeding practice:—

Six to Twelve months old.

1. 7 lb. hay; 10 lb. oat and tare silage; 10 lb. kale; 2 lb. oats.
2. 7 lb. hay; 10 lb. grass silage; 20 lb. mangolds; 1 lb. oats; 1 lb. beans.

Eighteen months old.

1. 10 lb. oat straw; 15 lb. oat and tare silage; 5 lb. hay; 20 lb. kale.
2. 10 lb. oat straw; 15 lb. grass silage; 5 lb. hay; 30 lb. mangolds; 1 lb. beans.

Thirty months old.

8 lb. oat straw; 9 lb. hay; 30 lb. grass silage; 40 lb. mangolds.

It is a common practice to give heifers in these age groups the worst quality hay, reserving the best for the milking cows; while this may be sound from the aspect of good milk yields, it is desirable to emphasize the fact that if second

quality hay is fed to heifers some compensating allowance of concentrates may be necessary to make good any nutritional deficiencies. When the heifers are within two or three months of calving more liberal feeding may be given with the object of calving them down in good firm condition. An allowance of 5 to 6 lb. daily of concentrates is then justified, especially during winter. There is not the same need for this extra feeding when they are running on good grass in summer. Here again the observation of the feeder must determine the procedure.

The systems of wintering dairy heifers are different in different localities. With younger heifers (yearlings) the commonest method is to confine them indoors, and good straw yards are ideal for this purpose. The advantages are that while they have plenty of freedom and good ventilation they also contribute to the making of good manure. In the North of England such animals are often confined in stalls, owing to the shortage of litter, and are turned out for exercise when they are watered. With older heifers the same systems prevail, though where sheltered grassland obtains, out-wintering is quite satisfactory in the drier parts of the country.

THE COMMON DISEASES OF DAIRY CATTLE

General principles having been enunciated, the following troubles are considered:—Tuberculosis, Mastitis, Contagious Abortion, Trichomonas-*disease; Sterility; Johne's Disease; Black-leg; Milk Fever.*

Prevent Diseases.

It should be a general aim to prevent diseases rather than to cure them. To this end the beginner must recognize that much can be done by good management, the utilization of modern veterinary knowledge and commonsense. Some dairy farms have an unsatisfactory history in respect of occurrence of disease, but from the outset it is essential that one should be on guard in this matter. On taking a farm, all buildings should be efficiently disinfected and subsequently should be kept clean. Buildings containing much woodwork are more difficult to deal with than those in which the floors, mangers and cowshed divisions are made of impervious material. The routine disinfection of the floors, walls and roofing is an aid to the control of disease; so also is the frequent cleaning of mangers, drinking bowls and troughs.

The common disinfectants used are chloride of lime, lime-wash and the various coal tar products like Jeyes Fluid. Chloride of lime or " Bleaching powder " has strong oxidizing and deodorizing properties, though its strong smell necessitates its use with caution in cowsheds, on account of the danger of tainting the milk. It is a suitable dressing for applying to the floors and mangers of looseboxes and calf pens. On occasions it has proved useful for disinfecting foul ponds. Lime-wash is prepared by mixing water with slaked lime and its germicidal properties are increased by the addition of 5 per cent of carbolic acid. The addition of milk, size, salt or alum prevents the lime-wash from rubbing off when it becomes dry after application. Before the lime-wash is applied, the walls and roof should be freed from dust and dirt. The use of blow lamps or flame guns is also very effective, particularly for the disinfection of mangers and woodwork.

Commonsense.

The exercise of commonsense in dealing with disease is likewise important. Sick animals should be isolated. A hospital box removed from the rest of the buildings is a valuable asset, with separate utensils, drenching bottles, buckets, halters and the like kept for ailing stock. In the absence of separate labour detailed for looking after animals off-colour, if there is any doubt as to the nature of the disease, the contacts with the sick animal should be left till the rest of the stock has been attended to. Disease is sometimes spread not only by direct contact of a diseased animal with a healthy one, but also by indirect methods such as contaminated labour, food, water, buckets, mangers, buildings, vermin and tainted pastures. On many farms, ponds are a serious menace to the health of livestock and if pond water *must* be consumed, then the ponds should be so fenced off that stock may not foul the water with excreta. A running stream or piped water are the best sources of water.

The detection of an ailing condition is by observation of the behaviour of the animal. The animal out on grass separates itself from the rest of the herd, appears arched in the back and tucked up in the flank and often has the hair of the coat standing on end. When kept inside, the animal is off its feed, fails to chew the cud, may run a temperature, while the bowels are not normal. The temperature of a healthy cow is between 101 and 102 degrees Fahrenheit, and this is taken by inserting a clinical thermometer in the rectum. If there is no clinical thermometer available, an ailing cow may be detected by very warm horns. A sudden drop in milk yield may indicate that the animal is in season, or otherwise is unwell.

Maintenance of Good Health.

Disease is probably the greatest enemy of the dairy farmer, since veterinary estimates indicate that practically two-thirds of the cows leaving a dairy herd do so on account of disease. The financial losses that dairy farmers incur through disease in this country run into many millions of pounds every year. Since 1940, it has been possible for farmers to arrange with their veterinary practitioner for the four principal diseases to be dealt with by means of a special contract, in which the veterinary surgeon undertakes to treat the herd for the maintenance of good health. The diseases covered by this arrangement are mastitis, contagious abortion, sterility and Johne's disease. The scheme in question is a new approach to the problem of controlling disease and for the first time in farming history, the veterinary profession is making a real attempt to prevent disease rather than to cure it.

Tuberculosis.

Tuberculosis is widespread amongst the cattle of dairy herds and it occasions much loss to milk-producers. Its presence, in an active form, must be suspected in the case of animals with a chronic cough, an emaciated or wasted state of body and any abnormal swelling or hardening of the udder. Any animal thought to be suffering from active tuberculosis must, under the Tuberculosis Order, be notified to the Police or Government Veterinary Officers who determine whether the case is one for disposal by slaughter. Compensation on an agreed scale is allowed, though this is not at replacement value.

When the disease occurs in the udder, there is a risk of infected milk resulting, and, in the absence of proper pasteurization, such milk is apt to be

dangerous for feeding to infants and young people. So long as herds contain cattle suffering from tuberculosis, there is no adequate justification for opposing the pasteurization of milk supplies for human consumption. It is indeed a commonsense precaution that should be welcomed by milk-producers as a whole, if only for the fact that it strengthens the confidence of the consuming public in the safety of the milk supply.

The control of this disease by eliminating reactors to the tuberculin test is recommended as the only safe policy in dairy cattle breeding.

Mastitis.

Mastitis is an inflammation of the udder, which may be produced by any one of several disease organisms. Hence mastitis is not a simple disease and careful diagnosis is necessary to ascertain which particular organism is responsible. In dairy-farming practice this is probably the most difficult disease to control and though much progress has been made by veterinary research workers in relation to it, much still remains to be done before the problem can be said to be solved. The commonest organism responsible for mastitis is *Streptococcus agalactiae*, which may be present even in the udders of cows not affected with mastitis in the active form.

The disease in the acute form is recognized by the affected quarter becoming swollen, with marked inflammation and tenderness, while the milk may be clotted or discoloured. It is important to treat this disease with the utmost care, since carelessness in the handling of affected milking cows may cause the infection to be carried to healthy cows. The normal precautions are the isolation of affected animals, and the proper disinfection of the hands after drawing milk from affected quarters, before proceeding with the milking of a healthy cow. There are many widely advertized remedies sold for this trouble, but it is a wise precaution to seek veterinary advice as to appropriate treatment. Simple cases respond to the application of hot water fomentations of the affected quarter several times a day, together with its frequent stripping. The strippings in question should not be drawn onto the floor, but into a pail containing disinfectant.

The routine use of a strip cup in a milking herd, for the purpose of examining the first few draws of milk from each teat prior to each milking serves the double purpose of discovering cases of abnormal milk, by which mastitis is first detected, and of reducing the bacterial infection in normal milk. One should always be suspicious of cows throwing flaky milk in the first few draws. Such cows should be noted and milked last, particularly in machine milked herds.

Contagious Abortion.

This is probably the most widespread as well as the most serious disease of dairy cattle. It is due to an infection, caused by an organism known as *Brucella abortus*, which veterinary surgeons can detect by means of blood testing. Hitherto many quack remedies have been introduced with wild claims as to their efficacy in controlling this disease which is one that causes premature births and often causes the sterility of the affected animals in the end. As a result of considerable research work by the veterinary scientists the disease can now be controlled by means of preventive inoculation. Two vaccines are in use. The first involves the inoculation of calves with a live vaccine when they are from 4 to 8 months old. The immunity resulting from this treatment lasts for several calvings. The second vaccine is known as Wye Vaccine No. 2 which is injected in two doses at intervals of about six weeks prior to heifers being mated. This, unlike the first vaccine does not produce, in the vaccinated animal, a reaction to the agglutination or blood test by which the infection is diagnozed.

The Ministry of Agriculture has now made arrangements to offer a service for the vaccination of heifer calves against abortion in the herds of registered milk producers at the low charge of 1/– per calf. The animals eligible for treatment under the scheme will be heifer calves of four months old and upwards and maiden heifers up to two months before service.

Trichomonas Infection.

Trichomonas infection, which is also responsible for abortions and sterility, is caused by a blood parasite and is in reality a venereal disease that is transmitted by the bull. The bull gets infected from a cow suffering from the disease and, once infected, he spreads the disease to clean cows when they are served. The disease should be suspected when several animals fail to hold to repeated services; when there are abnormal discharges for several weeks after cows have been served and when cows or heifers come in season in from two to four months after service. With this disease abortions occur within two to four months of service.

It is of the utmost importance to seek veterinary aid in the case of *Trichomonas* infection in the herd. Female animals can be cured, but unfortunately curative treatment for the bull is difficult and usually it is necessary to sell him for slaughter. The prevalence of this disease emphasizes the risk of buying a bull that has already been in service in a herd. Also neighbours' cows should not be received for service if there is any doubt about their breeding health.

Sterility.

The failure of cows to hold to service or to come into season is often troublesome and upsetting to the routine of maintaining a regular flow of milk in the dairy herd. Recent progress in veterinary research has been the means of

perfecting treatments with the result that about 80 per cent of affected cows can be cured. Sterility specialists are now attached to the provincial advisory centres for the purpose of advising practising veterinary surgeons on appropriate treatments in cases referred to them.

Johne's Disease.

Johne's disease is serious in some areas, and is diagnozed by intermittent scouring and a rapid loss of flesh. The disease is spread when cattle graze on contaminated pastures and drink from ponds which are infected from the dung of affected animals. Calves and young cattle in particular are readily infected ana there is no satisfactory cure of diseased animals. A measure of early diagnosis is possible from injections of johnin and reactors to this test should be isolated and subsequently disposed of. Infected pastures should be ploughed up and re-seeded and ponds fenced off to prevent pollution of the water supply.

Black-Leg.

Black-leg attacks young cattle from a few months old to the age of 2 or 3 years. On taking over a new farm it is a wise precaution to enquire as to the incidence of this disease, for it is particularly associated with infected pasture land. Young affected animals go stiff and lame and death quickly takes place. The animal swells in the affected part of the body and there is no cure. The disease can be prevented by the use of a vaccine and it should become a routine practice on all farms known to be subject to this trouble to vaccinate all calves and young cattle before turning them out to grass each spring.

Milk-Fever.

Milk-fever is now thought to be due to a deficiency of calcium in the blood and is met with in high-yielding cows, usually from their third calf onwards. The symptoms occur within 24 to 48 hours of calving, producing a paralysis of the hind quarters, which is at first detected by a staggering gait and a paddling motion when the cow is standing in her stall. Eventually the cow lies down and is unable to rise, and, in the absence of treatment, death results. Injections of calcium gluconate are usually effective in curing this trouble, but preventive measures adopted in ordinary farming routine are proper nutrition, especially in relation to the use of foods not deficient either in minerals or in vitamin D and the avoidance of milking the cow out dry for the first three days after calving. Leaving the calf on the cow for the first three days of its life has a similar beneficial effect.

BUILDINGS FOR DAIRY CATTLE

In this Section the following are dealt with, in the order mentioned:—Housing for Calves; Housing for Cows; The Milking Parlour or Milking Shed; Cowsheds; Liquid Manure; Cowshed Dung; Hospital or Loose Boxes for Cows; The Dairy; Housing for Bulls; The Bail System of Dairy-farming.

Housing for Calves.

The Maintenance of Good Health.

No class of stock deserves greater consideration than calves; yet on many farms the provision for them leaves much to be desired. Under ideal conditions their building should be isolated from the cowshed, for reasons of health. Adequate air-space, ventilation and light should be provided. A recognized air-space is 180 cubic feet per calf, but it should be associated with good ventilation, preferably of the ridge type. Draughts should be avoided, as these do not constitute good ventilation. An abundance of fresh air favours the maintenance of good health. A southern aspect ensures better lighting, but dark buildings can usually be improved by introducing roof-lights. Most farmers have to be content with the buildings they find already on their farms, but alterations can often be made to provide healthier rearing conditions, and the exploration of these possibilities should be the first step towards raising a clean herd of dairy cattle.

The flooring should be sanitary and capable of being thoroughly disinfected. Concrete that is well-insulated below by a layer of broken bricks, is very satisfactory, and can be recommended. The pens themselves need not be elaborate, but it is an advantage if all surfaces can be thoroughly cleaned. Wood is far from ideal, owing to the difficulties of proper disinfection. Tubular metal pen-divisions have many advantages, but brick walls lined with cement have also proved satisfactory.

In the early stages of rearing, a separate pen for each young animal is the ideal, as calves are often prone to suck one another if penned together. As calves like company it is an advantage for them to see their mates through the pen divisions. Suitable pen sizes for small calves are 4 feet wide and 6 feet long. The doors are best made of tubular metal and it is generally more convenient if space is provided outside the pen for the calves to put their heads through apertures or stanchions for taking their milk and trough food. All feeding utensils employed should be capable of thorough cleaning and disinfection, and if permanent troughs are fitted these should be of glazed construction.

When a new structure is contemplated, a building with a span roof provides better ventilation than a lean-to type and also makes possible a central feeding passage wide enough for a cart, to facilitate the cleaning out of boxes.

Suitable hay-racks should be provided, and preference should be given to those made of metal. Occasionally hay-nets are preferred for young calves.

When calves have left the bucket stage of rearing, usually at from two to three months old, they can be grouped together in larger pens or boxes. Many rearers now favour the use of partly open yards with a southern aspect for calves of this age.

One can quickly sense that the housing conditions for calves are not satisfactory if the atmosphere is stuffy and strongly charged with ammonia. Louvre or ridge type ventilators will usually cure this trouble in all span roofed buildings, while the drainage arrangements should be such that excess urine quickly drains out of the buildings, or is absorbed by peat moss litter and straw. In some parts of the country wooden platforms are utilized on the floors, but these are very unsatisfactory from the health standpoint.

Housing of Cows.

The Ideal Cowshed.

No unanimity obtains as to the ideal cowshed. A considerable difference of opinion exists on many matters of detail. On most dairy farms, milk-producers have to be satisfied with what they find and existing buildings will frequently have been modified already to conform to the requirements of local authorities. Modern lay-outs are not common and the improvement of existing buildings frequently involves making the best adaptation that is possible. It is unnecessary to assume that only new equipment and buildings will give satisfactory results, and as a matter of fact many modern structures have been designed to facilitate the production of clean milk without studying the comfort of the cows.

The ideal form of housing from the standpoint or comfort is to keep cows in well-bedded covered or semi-covered yards and to milk them in a milking shed or milking parlour. Such yards exist on farms in arable districts, formerly associated with the yard feeding of cattle in winter. The dairy cow can be utilized in this way as a producer of manure, but the system necessitates the availability of plenty of straw for bedding purposes. In keeping cows in yards it is an advantage if they are de-horned, and this operation must be performed when the animals are only a few days old. The great advantages of this system are the avoidance of injuries incurred through being tied up in standings, the saving in the loss of urine which is absorbed by straw and the production of better manure, the saving in labour in cowsheds because manure carting is concentrated at the times of the periodical cleaning out of yards, and the cows are cleaner. There is the further advantage that in suitable

yards the health record is more satisfactory, and, provided there is protection from prevailing winds in winter, cattle are not inconvenienced by being kept in yards that are only partly covered. This method combined with a milking parlour or shed, into which the cows go for the milking process allows one to satisfy the requirements of clean milk-production more cheaply and efficiently than by any alternative means. In summer the cows run out at grass and the milking shed is only used for milking purposes and for the feeding of concentrates. In winter, cleanliness in production can be more readily achieved, since there is no dusty straw for bedding and the dust can be satisfactorily controlled generally. It is often possible to house cows more cheaply to meet the requirements of modern milk-production in this particular way than if existing buildings were remodelled to satisfy the requirements of the Milk and Dairies Order. The possible disadvantages are that it is difficult to ration bulky foods and roots under this system where the cows are housed in yards, while they require more space than when tied up in standings, though they have the advantage of greater freedom and exercise.

THE MILKING PARLOUR OR MILKING SHED.

These are buildings constructed specially for housing cows during the milking process only. The milking parlour is the cheapest method of providing accommodation for dairy cows where the existing sheds are adequate for housing purposes but do not conform to modern requirements for clean milk-production. Normally these special parlours or sheds are equipped for machine milking, but may also be utilized for hand-milking.

The general lay-out under this system provides for the construction of a collecting pen into which the cows are driven from their winter housing or from the fields in summer. From the collecting pen the cows sometimes pass down a gangway where they can be held for washing purposes prior to going into the stalls of an auto-recording or other machine-milking outfit, which milks from three to six cows at a time, depending upon the size of herd. More frequently there are two sets of stalls, one in which the cows are prepared for milking and from which they pass forward into the other, that of the milking stalls. This arrangement is probably the ideal. In designing the layout under such conditions, it is essential to have a concrete floor that can be kept well-washed, and provided with adequate drainage. The collecting pen and stall divisions are best formed of tubular metal. The whole building should be capable of being washed down. This requires cement-rendered walls. In some cases a flat cement-rendered roof is chosen, but in the majority of cases a span-roof is favoured, providing ridge ventilation and adequate lighting.

COWSHEDS.

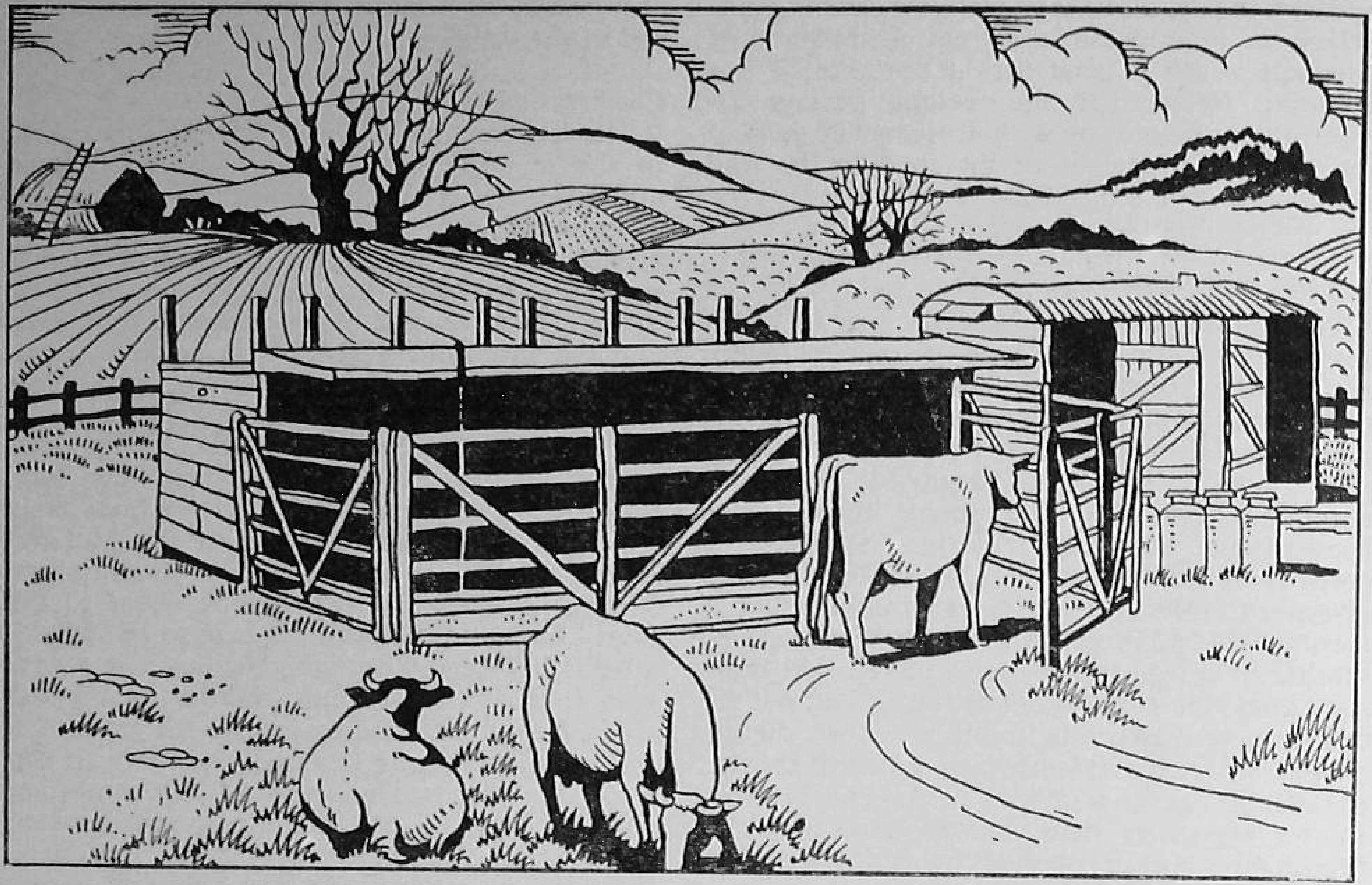
Details of Ease of Working.

While there is no uniformity about cowshed construction and design, there are certain recognized ideals which result from experience. The ideal lay-out is for the sheds to run from north to south, with a dairy on the north side. For convenience of working, the double-row shed is favoured on the larger farms with the heads of the cows facing the walls and a central gangway for cleaning out. With new constructions it is important to study details of ease of working, but in modifications of existing sheds improvements have, of course, to be effected within the limits of the existing buildings. There are four main points to observe in cowshed construction. The first is light, the second ventilation, the third comfort and the fourth cleanliness.

Lighting and ventilation are often inseparable, because windows can also be made to serve as ventilators. In general, however, the lighting should be so designed that it falls behind the cows and to this end properly arranged roof and wall lighting is important. Thus in single-row sheds, requirements can be met by having glass panels in the lower portion of the roof or in the wall adjacent to the gangway. In a single-range structure I have found no need for wall lights provided there is adequate provision for roof lighting so arranged that it concentrates the light on the hind-quarters of the cows. In double row sheds, the lighting may be part of the ventilation system in the walls, but this has the drawback of limiting the intensity of light in the gangway, and therefore some form of additional roof-lighting is necessary. Where this is incorporated at both sides of the apex of the roof, it can also be associated with ventilation as in the the Findlay-ridge type of construction. This, however, is more expensive than that incorporating ordinary louvre ventilators with fixed roof lights in the lower portions of the roof. The area of glass per cow should be from 2 to 3 square feet. Artificial lighting is equally important, and in double-row sheds this may conveniently be placed above the centre of the gangway, while in single-row sheds, wall bracket lighting may be used, with the light directed on the hind-quarters of the cows. The concentration of natural or artificial light in this way facilitates the production of clean milk.

Good Ventilation and Good Health.

Good ventilation and good health mean almost the same thing, and the ideal conditions provide adequate air-space in the building itself, with suitable inlet and outlet facilities for the exchange of air without encouraging draughts. From 600 to 800 cubic feet of air-space is necessary, but beyond this the common arrangements for ensuring an exchange of air are too often left to



THE MILKING BAIL.

the discretion of the workers looking after the cattle. For this reason it is desirable that provision should be made for a minimum of permanent ventilation with the addition of controlled ventilation when good supervision can be exercised. Defective ventilation is one of the commonest errors in cowshed construction. Too often the upper portions of the windows in the side walls are used as inlet ventilators, with the result that the air enters the cowshed well above the level of the cows so that the cool air tends to fall downwards on to the backs of the cows. The ideal is for the inlet ventilation to be as near to the ground as possible, and preferably on a level with the noses of the cows. Having tried a good many of the inlet ventilation systems, I favour the type which results from removing a brick on the outer wall and bevelling the aperture on the inside of the wall so that there is no direct draught and when this type is so arranged that one inlet ventilator serves two cows, very satisfactory ventilation results. Alternatives are to stick a glazed 4-inch pipe through the wall in front of each cow, with a downward bend on the inside of the building. The fact that cows benefit from inhaling the cool fresh air emphasizes the importantce of inlet ventilation.

Outlet Ventilation.

The outlet ventilation is equally important. In double-row sheds, the ideal is probably that provided by the Findlay-ridge system, the essential element of which is composed of glass sides, operating at the apex of the roof and providing both light and ventilation. The ventilator is operated by levers and when open the entire ridge of the roof acts as a ventilator. The ventilator can be adjusted in accordance with the needs and the weather. This type would not be suitable in a single-cowshed, owing the fact that in wet weather the rain would tend to fall on the backs of the cows. For single-row sheds the fixed louvre ventilator is recommended. Even in double-row sheds where expense has to be kept down to a minimum, the fixed louvre system is also very satisfactory. The louvres require to be properly made to give protection against heavy rain, and they should be covered with wire-netting to prevent birds from nesting or lodging in them. Sure signs that the ventilation is inadequate are a tendency for moisture to condense on the roof and a stuffy smell noticed on entering the shed in a morning.

For the structure of the building itself a variety of materials is employed, including brick, stone, concrete and in some cases wood. For single-row sheds a minimum width of 15 feet is necessary when there is no feeding passage, and 22 feet for a double-row shed. It is however desirable to study the problems affecting labour-saving when erecting a new building and to this end two worthwile conveniences are a feeding passage in front of the cows and a gangway behind the cows sufficiently wide to allow room for a horse

and cart to pass along it to facilitate cleaning out. Where it is impossible to get a building of adequate width it is of first importance, if not essential, to sacrifice the feeding passage altogether in favour of a wide gangway behind the cows. The height of the shed to the wall plates should be 8 or 9 feet.

Lay-out of the Stalls.

The lay-out of the stalls gives rise to much controversy as far as the type of standing, width and length are concerned. This results from the differences in the sizes of animals and the importance attaching to particular needs. The primary object should be to provide cows with accommodation that will enable them to be comfortable. Standings that are short, keep the cows clean but are apt to be uncomfortable and give rise to injuries to the hocks and knees. The theoretical ideal is that when the cow is standing up, her hind legs should be so placed that when she dungs, the gutter alone is fouled and not the standing, so that soiling the thighs when she lies down is avoided. It is obvious that with animals of different ages in a milking herd, heifers require shorter standings than mature cows and this need is often met in cowsheds by having standings of different lengths. It can be controlled also to some extent by the method of tying adopted. After considerable experience of different forms of stalls I favour the use of double stalls in which the divisions are made of reinforced concrete with a system of side ties, in preference to the use of tubular fittings with metal yokes. Experience suggests that the comfort of cows is thereby increased, while animals are more easily handled in such stalls when they have to be examined by veterinary officers and others. Furthermore such a system restricts the spread of infectious disease from cow to cow. As regards the ties themselves, I have found the rope ties used in the North of England more satisfactory than chains. The width of standing for the average Shorthorn type of cow should be from 6½ to 7 feet and the length from the front of the trough to edge of the standing should be about 7 feet 6 inches. Thus with a trough that is 2 feet 6 inches deep, the animal has a space of 5 feet in which to lie down or stand up. The best type of trough is one of glazed earthenware, as this material is kept clean more easily than concrete and is not affected by the action of foods, which often causes concrete troughs to become pitted. These glazed earthenware troughs are frequently set in concrete surrounds. The floor of the trough should be slightly above the level of the floor of the standing and the portion of the trough adjacent to the cow's body should not be so high that the cow is likely to damage her knees or brisket in lying down or getting up. A good fall on the floor of the stall is important. This should be in the order of 2½ to 3 inches from the trough to the end of the standing.

Construction of the Floor.

The construction of the floor itself is important. In the majority of modern sheds, concrete is utilized, but it is of the greatest importance that this should be properly insulated by a layer of broken bricks or drain pipes placed side by side to give a dry warm surface for the cows to lie upon. The advantage of concrete is its durability and the ease with which it can be kept clean. Floors composed of brick are warmer, but subject to wear, and are more difficult to keep clean and are therefore not recommended. Compressed asphalt and rubber compounds have also been used, but they lack durability. Rubber mats have proved very satisfactory at the Midland Agricultural College, though they are apt to be slippery and do not readily bed down to the floor. Concrete is sometimes held to be slippery after it has been worn smooth, but it is a wise plan to dust carborundum powder on the last six inches of the standing next to the gutter and this counteracts any tendency for cows to slip back into the gutter. It is equally important that the edge of the standing should be kept sharp and not rounded, as the rounded finish increases the tendency for the hind feet to slip off the standing into the gutter.

A floor that has become slippery can be improved by spraying acid on the floor surface after it has been washed clean with water.

The Manure Channel.

The manure channel or gutter should be wide enough to allow the urine to get away and deep enough to allow the cow to deposit her excreta overnight without any piling up that might soil the cow when she is lying down. Many gutters are too small and where possible at least 2½ to 3 feet should be allowed, with a depth of 6 to 9 inches next to the standing. The depth of the gutter next to the gangway need not be greater than 3 to 4 inches, the main object of this being to prevent splashing and to keep the dung and urine from spreading onto the gangway. In some cases where there is a lack of space for an adequate gangway and a wide gutter, the gutter and the gangway are merged, especially in single-row sheds, and this is quite a common arrangement in the North of England. A small depression is made in the gutter-cum-gangway to drain the urine away. The minimum width of gangway-with-gutter should be 5 feet in a single row shed and under ideal conditions the gangway itself should not be less than 5 feet. In double-row sheds an ideal width of gangway between the two manure channels is 8 feet. When feeding-passages are provided, these should be wide enough to allow a feeding barrow to be taken down them, and this requires about 4 feet.

The type of roofing used in a cowshed will

depend upon local customs. Most new structures are roofed with asbestos-sheeting or tiles which are quite satisfactory. It is of importance that the design of the roof should be such as to limit dust collection and to this end steel-work is cleaner than wood for the trusses, in view of the smaller surface area required. Since the war, circular asbestos piping has been utilized successfully for reducing the steel-work necessary.

The Walls.

The walls of the cowshed should be cement rendered to make it easy to keep them clean; and where a good smooth surface obtains there is little point in whitewashing the portion of the wall adjacent to the gangway. It is far better to keep the surface clean by washing with water when necessary. For the rest of the building one of the new cement washes such as " Snowcem " may be employed for giving a clean white and lasting surface and such a material possesses the additional advantage that it can be scrubbed or washed.

Liquid Manure.

Disposal of the Liquid Manure.

One of the most serious problems on most dairy farms is the disposal of the liquid manure from the cowsheds. The theoretical ideal is to conduct the urine to a specially constructed storage tank with a capacity of about 100 gallons per cow, and for the tank to be emptied at regular intervals when the liquid manure is applied to arable land. The emphasis placed on cleanliness in milk-production has introduced complications due to the washing down of cowshed floors so that considerable dilution of the urine takes place and there is a consequent increase in the volume of liquid manure to be dealt with. This difficulty may be overcome by a double drainage system, so that the washing water from sheds is diverted to a separate tank or soak-away or even directed into a ditch. Unless modern pumping machinery is installed for dealing with the liquid manure for distribution purposes, the process of emptying the tanks is apt to be laborious and costly. In any case the liquid manure system should include a settling tank to catch the sediment which must be cleaned out periodically. The availability of tractors and pneumatic tyred liquid manure carts has eased the difficulties of distribution, and when this material can be applied to arable land it serves as a substitute for nitrogenous fertilizers. A thousand gallons of liquid manure contain the fertilizing equivalents of 20 lb. nitrogen, 3 lb. phosphoric acid, and 46 lb. of potash; thus it possesses a definite manurial value, but when artificial fertilizers are in abundant supply it may be cheaper to buy the equivalents than to expend labour on dealing with the liquid manure.

Cowshed Dung.

Manure from the Sheds.

Cowsheds are required to be kept clean to satisfy the provisions of the Milk and Dairies Order. Under old-fashioned conditions manure from the sheds was frequently dumped in a heap in close proximity to the cowsheds, and left to accumulate until it was convenient to cart it away to the fields. In some cases covered yards were available for protecting the dung from washing by the weather. It is now generally recognized that it is desirable to store manure at a reasonable distance from the cowsheds and dairy and the heaps should be protected so that cattle do not have access to them. The reasons for this removal of manure from close proximity to the buildings are to reduce the fly nuisance and to avoid dust and dirt because all these have a bearing upon the health of the herd and the cleanliness of the milk. The best method of dealing with manure from the cowsheds is to have the gangways wide enough to take a low-loading cart and to clean out direct into the cart. Thus double handling of the manure is saved because it can be taken straight from the cowshed to the field where it is to be used, either for direct application or for heaping or clamping. Where the gangways are too narrow for the passage of a cart, it pays to construct a manure ramp up which a barrow can be wheeled and at the top the manure can be tipped into an empty cart. The labour saved by this method is considerable. In addition it ensures a freedom from unsightly and smelly heaps in close proximity to the buildings.

Hospital or Loose Boxes for Cows.

Boxes.

A necessity on all breeding farms is a hospital box—or boxes—isolated from the cowshed. This provision is needed for animals that are ailing or calving. The minimum size should be about 12 feet square and the boxes, if several in number, should be separated from one another by being walled up to the roof. The box should have a well-insulated concrete floor, with adequate fall to keep it dry, drainage on the outside and it should be adequately ventilated and lighted. The best aspect is for the doors to face south, the doors being divided so that the upper half can be left open when necessary. A desirable number of boxes is about one to every twelve cows. The interior of the box should be capable of being thoroughly disinfected after use and it is an asset to have a fitted glazed trough and side tie with a hay rack.

The Dairy.

Construction of the Dairy.

The dairy should have no direct contact with the cowshed and preferably should have a

northern aspect. When new erections are being made, there should be a minimum of two separate rooms and ideally three. The cooling room should be separate from the receiving and sterilizing rooms. Dust is the great enemy of milk from a keeping standpoint and thus it is best to have an arrangement whereby the milk is poured into a receiving tank that is separated from the cooling room with a pipe connection through the wall. The construction of the dairy should be such that the interior can be hosed down, for which reason cement-rendered walls are very suitable. Lighting should be adequate and preferably on the north side, while the ventilation should be carefully studied to avoid draughts and the blowing in of dust from the outside. The receiving room should be large enough to allow a wash basin to be installed for milkers to wash their hands. The cooling room should be adequate for the storage of the number of churns that will require to be filled at two milkings, while for washing and sterilizing the space should be sufficient to accommodate a washing trough and sterilizing chest. When a steam boiler is utilized for the generation of steam, this is usually in a separate shed adjacent to the sterilizing chest.

Housing for Bulls.

Ideal Housing.

The proper housing of bulls ensures a longer breeding life and better temper and control. Plenty of exercise appears to be essential for the maintenance of high fertility and this is not possible when bulls are kept tied up in a cowshed or small loose box. The ideal housing arrangement is to provide a loose box of reasonable size, say 12 feet square attached to which is an open-air exercising yard, with a concrete floor and with tubular iron rails so that the bull has an opportunity of seeing other stock. The size of yard will depend on the space available, but in general it may be from two to three times the size of the box. Adjacent to the exercising yard a breeding stall should be arranged. This serving stall can be so constructed that the weight is taken off small heifers, while in the case of large cows to be served by a young bull suitable depressions can be arranged in the ground. Access to the bull loose box for feeding purposes should be so arranged that the attendant does not require to enter the box. A yoke tie installed in the manger and controlled from the feeding passage will enable the animal to be caught when required. The roughened concrete floor of the yard is of great value in keeping the feet sound and level. Bulls that are confined to standing on littered loose boxes tend to get over-grown hooves.

The Bail System of Dairy Farming.

The Bail.

This is an all-the-year round out-door system of milk-production, introduced from New Zealand and popularized in England by A. J. Hosier, a Wiltshire farmer. By this method permanent buildings are dispensed with, the cows being milked on the pastures on which they graze. The milking is done in a portable shed (bail) equipped with a milking machine. The bail consists of six stalls, with three machine milking units, so that three cows are milked at the same time and three are prepared for milking. The outfit is managed by a man and a boy, who look after 60 to 70 cows. The portable milking shed is mounted on wheels or skids, the latter giving greater rigidity. The cattle are collected into a pen adjacent to the milking shed prior to milking. The stalls are simple in design, the cows being penned in by a chain across their buttocks. A trough is attached to the door at the front of each stall and deliveries of concentrates are made from a shute so that a measure of controlled rationing is possible. After the cow is milked the door in front of her is opened from behind the cow by a hand lever and the cow passes straight through on to the grazing pasture.

Associated with the portable milking shed is a compartment that houses the petrol or paraffin engine for supplying the power for the vacuum pump. Provision is now often made for a dynamo to supply electric light and a boiler and sterilizer. Cooling devices have also been installed so that the milk can be sent straight to the dairy or retailer.

The system has many advantages. Clean milk can be produced under open-air conditions in the absence of suitable permanent buildings. Remote grassland can be utilized for milk-production and the daily movement of the shed and collecting pen ensures an even distribution of manure. Manure carting from permanent buildings which constitutes a heavy charge on labour is avoided, while the bail system fits in with the requirements of alternate husbandry and Wiltshire and Hampshire farmers have found it an effective method of reclaiming Down land. It is essential that the fields utilized for bail milking should be suitably watered. This may prove an expensive matter with outlying land. The cost of equipment is about £6 per cow for a 70 cow unit, as compared with the £25 to £40 per cow in the case of permanent buildings. The probable life of a bail outfit is from 10 to 15 years and the number in use is several thousands. There are additional expenses such as having available an old tractor for hauling the bail onto fresh ground every day, though the bail can be moved by the horse that takes the churns, concentrated food, water etc., to the bail and collects the milk.

Cattle Outside all the Year Round.

As this sytem means keeping cattle outside all the year round, the fields selected for winter should be well-drained and provided with some natural shelter. In these days of surplus straw the collecting pens can be liberally littered and the

used portion of the field subsequently ploughed up for arable cropping. The health of the cattle managed in this way has proved very satisfactory and the bail is used in some large tuberculin tested herds. Since heifers respond to machine milking better than cows that have been hand-milked it is customary to form the bail-milked herd of heifers in the first instance. Milk-yields by this system are not so heavy as by the more normal method, but in practice it is found that the advantages of low capital and labour costs, the improved health of the herd and the utilization of remote land together with its improvement more than compensate for yield reductions. Controlled rationing is, of course, not possible to the same degree as with stock milked indoors.

SECTION III

GOOD SHEEP FARMING

by

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Illustrations from the pen of his daughter

JULIA TINLEY

AUTHOR'S NOTE

Both the World War of 1914–18 and that of 1939–45 brought about considerable reductions in the sheep population of the British Isles. In each case the chief cause was the ploughing up of much of the grassland normally used for sheep production, so that wheat, potatoes and other crops needed for direct human consumption could be grown. At the same time, much of the arable land normally producing green crops or root crops for feeding sheep was now employed for raising crops directly required for human food; the crops in question were wheat, barley, sugar beet and potatoes.

As the extreme shortage of world foodstuffs draws to a close there will be a gradual recovery of the sheep population. When supplies are equal to demand, much of the land which has been growing wheat, sugar beet and potatoes during the emergency will be found to be uneconomical for these crops and will naturally revert to its former use and carry again the normal sheep population. Time, Government policy, the state of international trade and of world supplies will all play a part in bringing about this end.

Throughout the year there is constant interest attached to the sheep flocks which produce meat for our table and wool from which the best of our clothes can be made, for the operations of sorting, mating, lambing, washing, shearing and dipping succeed one another and attract our attention. Those who do not belong to the farming community almost invariably think of the sheep as a dull and stupid animal. How wrong they are!

It is the author's wish that those who read this book may understand something of the continual interest that is woven into the sheep farmer's life and work. The sheep not only provides this interest but it is also the inspiration of the patient and conscientious work which shepherds pursue in all the varied weather of our changeable climate. To these shepherds tribute is frequently paid by those who are familiar with their occupation and by all who are fortunate enough to work with them.

What is written here about sheep is meant to enable students and others to gain a rapid yet reasonably comprehensive knowledge of sheep farming, and of the marketing both of the animals themselves and of their wool. It is hoped that the established sheep farmer will find interest and help in the references to research work in the list of pamphlets and books and in the tables at the end of the section.

The author wishes to acknowledge the help received from Professor M. M. Cooper of Wye College who made many helpful suggestions after being kind enough to read the draft of this section.

After the Author's explanatory note the sheep population of the United Kingdom is considered in relation to that of other countries of the world. Home production, imports, home demand, the carcase and the use of its various parts are discussed. The advantages and disadvantages of sheep on a farm are explained.

The Sheep Population.

Before discussing our own sheep farming it is important to compare the numbers of the sheep population in different parts of the world so as to appreciate the figures for the British Isles. Figures for the sheep of the world and of the United Kingdom are shown in Tables 1 and 2. It is interesting to note that human and sheep populations bear little, if any, relation to one another.

TABLE 1

SHEEP POPULATION OF ENGLAND AND WALES, SCOTLAND AND TOTAL

	England & Wales	*Scotland*	*Total*
1895–1904	18,894,810	11,573,517	30,468,327
1905–14	18,716,399	11,041,193	29,757,592
1914	17,259,694	7,025,820	24,285,514
1915	17,522,577	7,075,798	24,598,375
1916	17,951,123	7,055,864	25,006,987
1917	17,169,857	6,873,234	24,043,091
1918	16,475,175	6,878,198	23,353,373
1919	15,124,313	6,410,039	21,534,352
1920–29	15,174,175	7,036,706	22,210,881
1937	17,194 000	7,518,000	24,712,000
1938	17,508,000	7 840,000	25,408,000
1939	17,986,000	8 007,000	25,993,000
1940	17,683,000	7 783,000	25,466,000
1941	14,686,000	6,759,000	21,445,000
1942	13,932,000	6,831,000	20,763,000
1943	12,933,000	6,766,000	19,699,000
1944	12,602,000	6,833,000	19,435,000
1945	12,597,000	6,899,000	19,496,000
1946			
1947			

These figures show clearly that the sheep population is not liable to any wild periodic variation, but that it tends to fall in wartime. The comparative stability of the figures is due to the very large area of mountain, hill, moor and fell which can most profitably be used for sheep. Such land carries a fairly regular number of sheep whatever the local and international political conditions happen to be. The fall during the two wars is explained by the fact that many of the lowland sheep pastures are ploughed in times of national emergency, so that the stored fertility of these pastures can be used to grow crops for direct human consumption. Chief among such crops are wheat, potatoes, barley, sugar beet and oats, all of which provide more human food from an acre of this pasture land than would be obtained by sheep grazing.

Before the second World War the mutton and lamb produced at home were worth £24 million a year. The corresponding value of the wool was £4 million, so that the sheep farming of the United Kingdom has made quite a considerable contribution to the Nation's wealth.

TABLE 2

SHEEP POPULATION OF COUNTRIES OF THE WORLD

Country	*No. of Sheep*	*Numerical Order*	*Last available Data*
U.S.S.R.	80,000,000	2	1946 (est.)
Australia	93,500,000	1	1947
U.S.A.	38,500,000	5	1947
Union S. Africa	35,000,000	6	1946
Argentina	54,500,000	3	1947
French N. Africa	19,000,000	11	1946
New Zealand	32,500,000	7	1947
China	20,000,000	10	1946
U.K.	17,000,000	13	1947
India	50,000,000	4	1946
Spain	23,000,000	9	1946
Peru	14,000,000	14	1942
Uruguay	26,000,000	8	1942
Brazil	12,500,000	16	1946
Roumania	7,000,000	18	1946
B.E.A.	7,000,000	18	1945
Italy	7,000,000	18	1946
Turkey	18,000,000	12	1946
France	8,000,000	17	1946
Iran	13,000,000	15	1947
Bulgaria	8,000,000	17	1946
Greece	6,000,000	19	1946
Canada	2,000,000	22	1946
Yugoslavia	5,000,000	20	1946
Germany	4,000,000	21	1946

For 1929, the total sheep population of the world was estimated to be over 700 million (Empire Marketing Board, 1932). In some countries, where there may be nomad tribes, it is almost impossible to obtain a census of the sheep population. The British Empire has a vast wealth of sheep and the United Kingdom itself, although so small in area, was seventh on the list in the world census for 1929. It has a denser sheep population than any other country in the world except New Zealand. This is to a large extent due to the large areas of mountain, hill, moor and fell suitable only for sheep and due to the establishment, hundreds of years ago, of a very large sheep population partly to add fertility to our soils but primarily to produce wool. It was around this established sheep population that our woollen industry was built up in later years. The importance of our home-produced wool has declined with the increased imports of Australian and other wools, though our home production is

still about 95 million lb. per year. Wool is one of the few agricultural products which we export; incidentally, these exports consist mainly of the coarser wools for carpet manufacture and for tweeds. In the United Kingdom the emphasis is now laid upon the production of mutton and lamb, and the wool available is looked upon merely as an incidental benefit.

Home Production.

Between the two World Wars, very great changes occurred in the distribution and management of the sheep in certain areas of the United Kingdom. It is not necessary to enter into the detail of these changes; anyone who wishes to do so will find the matter fully covered in a paper entitled *Recent Developments in the Breeding and Management of Sheep in Great Britain* (R. G. White, 1929)*. The change described by Professor White was mainly one of reduction of the sheep population in arable areas and an increase of sheep population in the grass areas. Table 3, reproduced from an address by Professor White called *Sheep Farming: A Distinctive Feature of British Agriculture* (R. G. White, 1932) illustrates this point. Table 4, reproduced from statistics of the Ministry of Agriculture, shows the sheep population of England and Wales, county by county, and is included here in order to present as clear a picture as possible.

* Refer to the list at the end of this book.

TABLE 3

CHANGES IN SHEEP POPULATION OF COUNTIES OF GREAT BRITAIN, 1900–1930

– *over* 40%		– 20–40%		– 0–20%		+ 20%		+ 20–40%		+ *over* 40%	
Cambridge	65	Notts	35	Kent	19	Westmorland	16	Denbigh	35	Anglesey	76
Berkshire	60	Somerset	31	Warwick	15	Hereford	11	E. Lothian	38	Flint	52
Suffolk	60	Staffs.	28	Worcester	15	Northumberland	10	Fife	34	Kincard	68
Wilts.	59	Derby	26	Cheshire	12	Cumberland	10	Aberdeen	29	Caithness	57
Hants	58	Leicester	25	E. Riding	7	Lancashire	9	Berwick	26	Banff	47
Norfolk	53	Cornwall	23	W. Riding	2	Durham	4	Dumfries	23		
Surrey	50	Northants	21	N. Riding	1	Devon	2				
Essex	50	Bucks	21	Shropshire	2	Montgomery	19				
Dorset	50	Moray	26	Glamorgan	2	Radnor	13				
Lincoln	49	Argyll	24	Merioneth	1	Pembroke	12				
Bedford	45			Monmouth	3	Cardigan	11				
Oxford	41			Inverness	17	Carmarthen	11				
Sussex	41			Roxburgh	13	Caernarvon	10				
Herts	41			Bute	9	Brecon	2				
				Perth	8	W. Lothian	14				
				Sterling	2	Wigtown	9				
				Lanark	2	Selkirk	8				
						Peebles	8				
						Sutherland	7				
						Ross	6				
						Midlothian	5				
						Ayr	4				

TABLE 4

SHEEP POPULATION OF ENGLAND AND WALES, COUNTY BY COUNTY

Reproduced from Ministry of Agriculture Statistics for 1944

England

Bedford	19,788	Dorset	97,395	Lancaster	319,589	Northampton	193,552
Berks	45,599	Durham	206,693	Leicester	102,047	Northumberland	892,320
Bucks	87,535	Essex	61,512	Lincoln (Holland)	3,221	Notts	66,650
Cambs	35,632	Gloucester	140,921	Lincoln (Kesteven)	88,123	Oxford	83,286
Isle of Ely	3,025	Hants	86,585	Lincoln (Lindsey)	264,296	Rutland	38,116
Chester	43,607	Isle of Wight	10,447	Middlesex	3,512	Shropshire	336,107
Cornwall	222,014	Hereford	349,973	Norfolk	96,100	Somerset	285,436
Cumberland	540,323	Hertford	28,076			Stafford	86,471
Derby	105,758	Huntingdon	15,063			East Suffolk	44,631
Devon	805,057	Kent	455,451				

TABLE 4—*continued*

West Suffolk	39,121	Wiltshire	119,936
Surrey	13,595	Worcester	96,173
East Sussex	81,498	East Yorks.	250,783
West Sussex	37,869	North Yorks.	604,916
Warwick	115,516	West Yorks.	603,028
Westmorland	420,823		

England Total: 8,654,506

Wales

Anglesey	73,692	Glamorgan	297,605
Brecon	553,828	Merioneth	506,661
Caernarvon	327,577	Monmouth	215,872
Cardigan	295,109	Montgomery	568,881
Carmarthen	230,652	Pembroke	96,187
Denbigh	363,166	Radnor	355,873
Flint	62,392		

Wales Total: 3,947,495

Isle of Man	**Scotland**
74,958	6,833,000

Table 3 shows clearly that arable areas have lost sheep and that grass areas have gained them. This is due to a variety of causes. The arable sheep were folded for most of the year on root crops such as turnips, swedes, mustard, rape and kale. These crops were expensive to grow, but the expense was considered to be justified because the treading of the sheep consolidated the light lands on which these crops were grown, the manure from the sheep added fertility to the soil and the crops were grown in rows and could therefore be kept clean. This policy made it possible to grow the following crop of corn without additional manure. Such a system of folding sheep required much labour, and constant attention was needed throughout the year. The advancing cost of labour, from 1924 onwards, coincided with the substitution of sugar beet for other crops on much of the root area. About 400,000 acres of sugar beet are now grown. The sugar beet tops and the crowns (the part of the plant which is removed before despatch to the factory) it is true, provide some sheep food, but not as much as the earlier root crops gave. A further development coincident with the introduction of the sugar beet crop and the increasing labour costs was an increase in the use and availability of artificial fertilizers to take the place of the manure formerly provided by the sheep. So the arable sheep flocks were gradually reduced and the land which grew their food was turned over to sugar beet and cereals, artificial fertilizers being employed where necessary to help the new plan. The rise in sheep population in the grass areas was attributable mainly to an increase in fat lamb production from grassland during the summer months. The position of arable sheep farms to-day is adequately described in many writings (e.g. Sanders and Eley, 1946) and most authorities are agreed that these farms will have to find a more economical way of running the sheep than on arable folds and also a more economical labour system so as to make a shepherd responsible for many more sheep than heretofore, the sheep being run on a ranching scale.

Imports.

Table 5 shows the imports of mutton, lamb and wool into this country in recent years and also gives figures for their home production.

TABLE 5

	Mutton and Lamb		*Wool*	
	Home Production tons	*Imports tons*	*Home Production lb.*	*Imports lb.*
1938	211,000	346,000	114,000,000	881,000,000
1939	238,000	328,000	117,000,000	901,000,000
1940	227,000	403,000	113,000,000	1,075,000,000
1941	172,000	322,000	92,000,000	331,000,000
1942	168 000	371,000	92,000,000	411,000,000
1943	158,000	416,000	92,000,000	270,000,000
1944	141,000	372,000	86,000,000	508,000,000
1945	134,000	365,000	84,000,000	498,000,000

These figures show that in the days before the Second World War we produced 40 per cent of our mutton and lamb requirements and imported the remaining 60 per cent. During the war, imports remained very much the same in weight, but the home production figure fell with the reduction of the sheep population.

Imported mutton and lamb come to this country mainly from New Zealand, Argentina and Australia.

These countries have the same advantages that the Danes have had in competition with our own bacon industry. Every carcase produced in these countries comes under a critical eye before it is exported; if it is not up to the required standard it never reaches the United Kingdom, but is used in its country of origin or for processing and canning. In the United Kingdom, lambs, yearlings and draft ewes of all ages are slaughtered and their carcases find their way into our butchers' shops, with the result that the housewife periodically buys a joint from an old ewe and promptly decides that home-produced mutton is no good. Some kind of grading system will have to be established in this country to enable the housewife to buy home-produced mutton and lamb of standard grades, with the certainty that the same quality can be purchased again at a later date, if it suits her requirements.

Several factors militate against our mutton and lamb trade. Firstly, we have a great number of different breeds and an even greater number of crosses; in a recent survey in the south-west province there were found to be 82 different crosses. This naturally causes differences in carcase which are not found to the same extent in imported meat because this is produced from fewer breeds. Secondly, our season for the sale of fat lamb is short because our flocks almost all lamb during the period from January to April

with the peak during March, thus a large number of lambs reaches the market during July and August and there is a corresponding dearth during the rest of the year.

Possible solutions to this problem are discussed on page 604, under the heading of ' Food for Thought '. The third factor which operates against home-produced mutton and lamb is the fact that it frequently reaches the consumer too soon after killing so that it is somewhat tough;

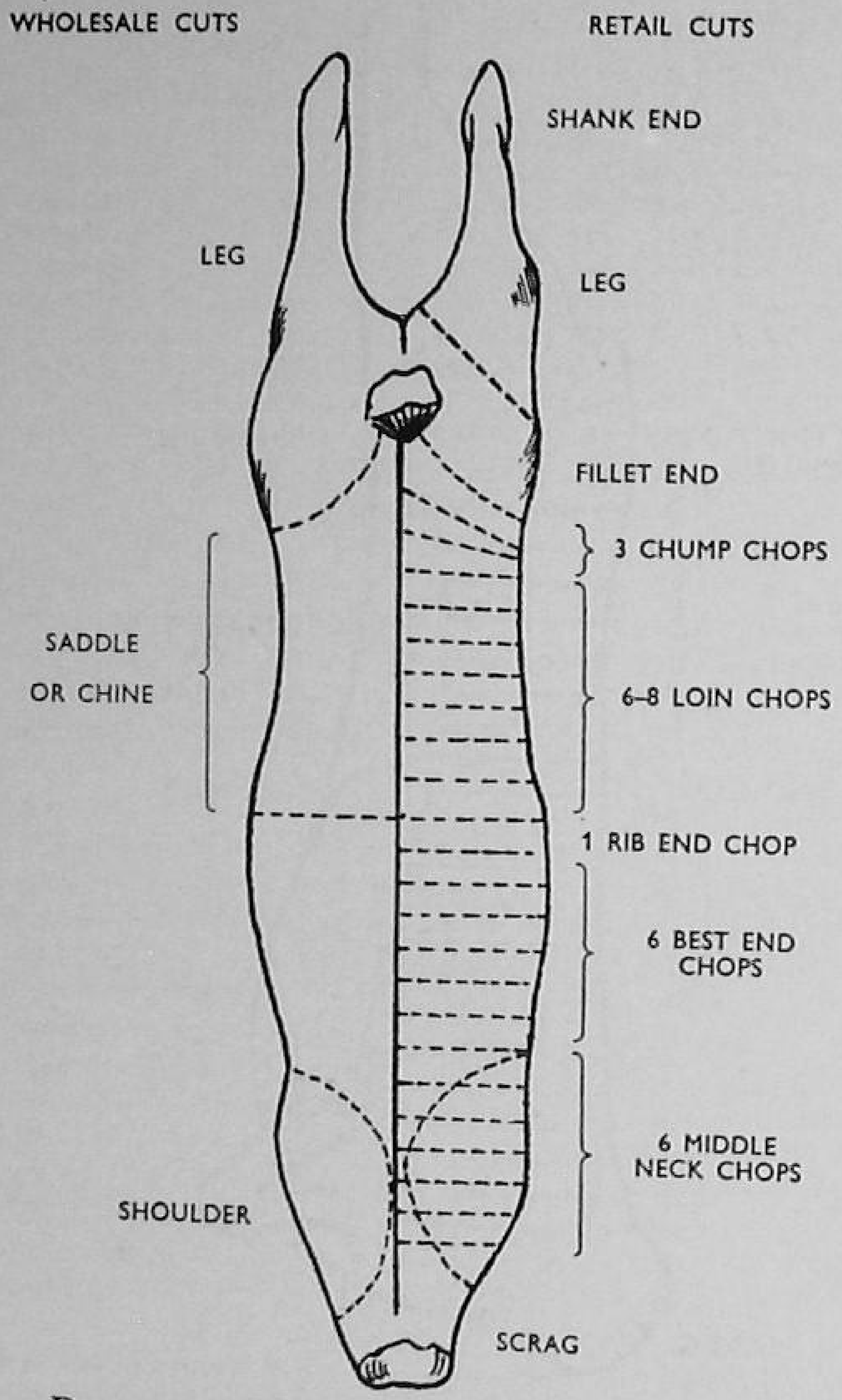


DIAGRAM OF MUTTON CARCASE, ILLUSTRATING WHOLESALE (left) AND RETAIL (right) CUTS IN LONDON

it is a well known fact that hanging a carcase after killing makes it more tender. Thus the difficulty of much of the tough meat could easily be overcome either by the butcher or by the housewife.

Demand.

In 1928, the quantity of mutton and lamb consumed per head of population in Great Britain was 28 lb. France only consumed 6·8 lb., Canada 6·5 lb., U.S.A. 5·8 lb., Germany 1·6 lb., and Belgium 1·3 lb. These figures indicate that Great Britain is a very heavy sheep-consuming country. Since the population of the country is some 40 million and the average sheep carcase weight about 40 lb., each change in the annual consumption of mutton by 1 lb. per head corresponds roughly to 1,000,000 carcases. This figure has a practical application because the consumption per head may well be increased when rationing ends, now that the earning powers of most people will bring the relatively uneconomical mutton joint within the scope of their purses.

The demand for mutton and lamb is to some extent seasonal, though not as noticeably so as in the case of pork. Mutton or lamb eaten cold being a hot weather dish, demand is greater during the summer months. During the Easter and Whitsuntide holidays the demand for mutton and lamb rises and it is fairly constant throughout the summer months. As winter approaches, the supply of lamb decreases and the supply of mutton increases the relative demand for the home or the imported carcase being largely governed by price.

In recent years before rationing the demand for a small joint was in evidence in the same way as in the case of beef and pork; the usual family requirement being for 3–, 4– or 5–lb. joints. These are best obtained from carcases ranging from lambs weighing 32 lb. dressed weight to mutton carcases weighing up to 64 lb. dressed weight. Carcases over that weight realize less money per lb.

The Carcase.

A dressed lamb carcass of Smithfield Fat Stock Show quality is 54 per cent of the live weight of the lamb; a dressed carcase of a similar quality, but older, sheep is 56 per cent of the live weight. These figures represent exceptionally good quality animals and the corresponding commercial figures would be lower and might range from 40 per cent upwards. The popular carcase must be tender; the older the sheep the less tender will be the carcase. The weight of the dressed carcase should range from 30 lb. in the case of early fat lamb to 65 lb. in the case of sheep under a year old. The less popular larger carcases of up to 80–90 lb. in weight are produced from two-year old and three-year old wethers and from draft ewes of the larger breeds. It is a popular belief that the three-year-old wether is no longer to be found, but this is untrue in at least one part of the British Isles (Romney Marsh), where some three-year-old sheep are still to be found on some of the well known fattening pastures. The bone of a good carcase must be fine and the flesh of a lightish pink colour—not dark red. The carcase should be compact and relatively heavy in the hindquarters where the

more valuable joints lie; the loin and leg for example should be well developed and the latter fleshed almost down to the hock. The fat should be firm, white and not more than half-an-inch thick. The popular size of carcase and the quantity of fat acceptable to the community differ somewhat in different parts of the country; in areas where most of the labour is employed in heavy industry, the joints may be larger and fatter.

In addition to the parts of the carcase shown in Figs. 1 and 2, a considerable quantity of edible offal is available when a sheep is killed. This consists of the head (including the tongue), kidneys, pluck (heart, liver and lungs), sweetbreads, fries and caul (abdominal cavity fat), and the lining of the stomach (tripe). The value of this offal is roughly one-tenth of that of the carcase so that they represent a not inconsiderable part of the butchers' returns.

The skin of the sheep is the most valuable of the inedible offal. It is sold to fellmongers, the cash return obviously depending largely on the quantity of wool adhering to the skin at the time the sheep is killed. The skin must be carefully removed from the sheep because if there are cuts, loss ensues when the process of splitting the skin is carried out prior to its flesh side being used for the production of " chamois " leather.

Inedible fat or tallow is used in the manufacture of lower grade soaps, glycerine and commercial greases. The intestines are used for the sausage casings, surgical stitches and strings for musical instruments and tennis racquets.

The thyroid, pituitary, thymus and prostate glands collected in the large abattoirs are valuable in the preparation of pharmaceutical products.

The Advantages of Sheep.

(1) The sheep requires little concentrated food as compared with cattle or pigs. The majority of lowland ewes receive in normal times, some cake or corn, but liberal feeding only requires about 1 cwt. per ewe per year.

(2) The sheep is an economical converter of grass into human food or wool, in fact on some mountains, hills, moors and fells the sheep is capable of producing mutton and wool where no other livestock would live.

(3) At certain times grass fields should be grazed completely bare. The sheep is capable of grazing more closely to the ground than other stock and is therefore an excellent cleaner of pastures, removing tidily any surplus growth which is not required.

(4) Sheep spread their dung very evenly over the ground and consequently when the grassland or arable land, on which they have been running, is ploughed up, the land is not only enriched, but this increased fertility is evenly distributed.

(5) The residues of the sugar beet crop or market garden crops such as brussels sprouts, savoys or cabbage may profitably be fed to sheep.

(6) In recent years the combine harvester has come into common use. This machine threshes out grain from the standing crops of corn and the straw is commonly left lying on the ground. Subsequent treading by sheep is invaluable in breaking up this straw, trampling it down onto the ground and so enabling it to be ploughed in more easily. In this process the sheep obtain their food from the straw, and the fallen ears of grain as well as from the grasses and other plants growing in the stubble.

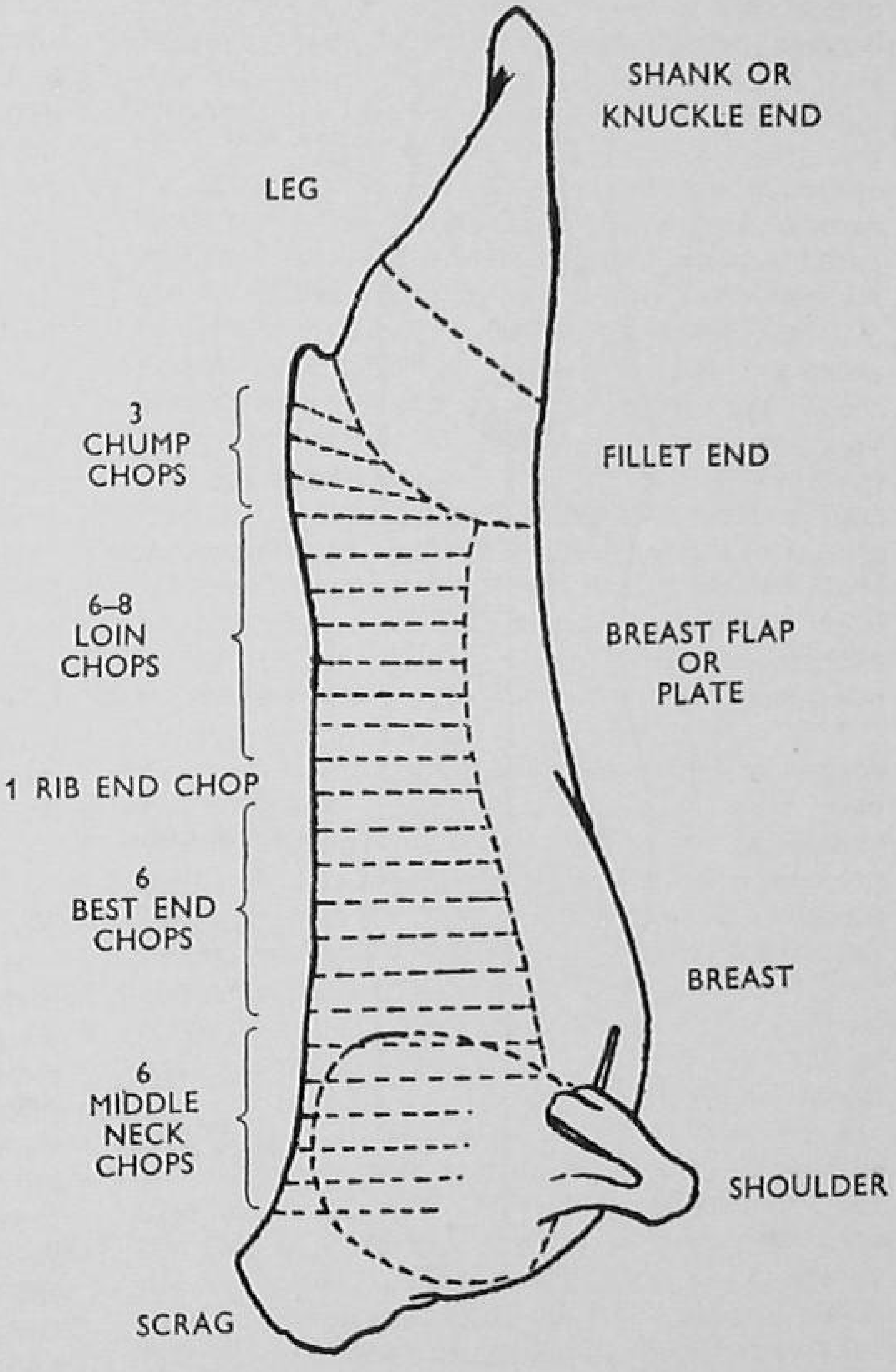


Diagram of Mutton Carcase, Illustrating Retail Cuts in London

BREEDS OF SHEEP

The general characteristics of British Longwool, Down and Mountain Sheep are discussed. Notes on British breeds are given individually. Crosses which are in common use are explained.

Introduction.

GREAT BRITAIN possesses over 30 different breeds of sheep. Most of them have local, if not wider, importance in these islands, many of these have been exported to countries overseas. Many critics in this country and overseas are of the opinion that this number of breeds is absurd; they say that they cannot all be necessary and that their existence causes lack of uniformity both in carcase and wool; that, moreover, since each breed society usually claims that its breed is adaptable and that it has been exported to widely differing climates overseas, it obviously cannot be necessary to have a separate breed especially to satisfy the conditions in each small area of our very small country. These criticisms are in the main valid and in fact several breeds in this country have in recent years decreased in numbers almost to the point of extinction. Nevertheless a large number of our breeds are still very flourishing and show no signs of diminishing in numbers except that there was a general fall in sheep population during the Second World War.

Much bold and comprehensive research is necessary if a new breed is to be introduced into a new area to overcome local prejudice and endeavour to eliminate small local breeds by provision of an adequate substitute. Local prejudice is extremely strong, as everyone will remember who was in Kent when the Scotch Half-Bred was introduced to quote only one example. There are three main classes of sheep in the British Isles: longwool, mountain and down breeds.

LONGWOOL. These are nearly all of large size and produce a large carcase, frequently too big for modern requirements. They graze or are folded on good land seldom more than 200–300 ft. above sea level. Their wool is coarse, but the fleece is heavy and the wool very long. All the longwool breeds have white faces and neither sex has horns.

MOUNTAIN. These are small sheep, producing small carcases of very good flavoured mutton. During their early life the ewes are run on mountains, fells and moorlands, but they are often sent to lowlands for their last one or two crops of lambs. Most of the breeds have horns and many have black or speckled faces. The wool is coarse and though it may be long, the fleece is light in weight.

DOWN. These produce fairly small, early maturing carcases suitable for modern tastes. The quality of both mutton and wool is high, though the fleece is usually light in weight. The majority of the down breeds are hornless. Many have black or brown faces.

The existing breeds are shown in their respective groups in Table 6.

TABLE 6

Longwool	*Mountain*	*Down*
Leicester	Scotch Blackface	Dorset Horn
Border Leicester	Swaledale	Wiltshire Horned
Lincoln Longwool	Rough Fell	Ryeland
Wensleydale	Derbyshire Gritstone	Southdown
Cotswold	Lonk	Devon Closewool
Kent or Romney Marsh	Penistone	Shropshire
	Hedrwick	Suffolk
Devon Longwool	Cheviot	Dorset Down
South Devon	Welsh Mountain	Hampshire Down
Dartmoor (almost a mountain breed in use)	Black Welsh Mountain	Oxford Down
	Exmoor	Kerry Hill } These are almost mountain breeds in use
		Clun Forest }
		Radnor }

Broadly speaking the breeds are found in the county or district whose name they bear, and details of these breeds are given in tabular form (pp. 579–589), so that the reader may easily obtain information upon any particular point in which he is interested. Some comment is necessary on the various headings under which the information is shown.

The lamb averages of the various breeds are not given; this is a notable omission for which there are two reasons, firstly, some of the information obtained from breed societies is incomplete and secondly, the methods of calculating the lamb average differ. Some breed societies and farmers calculate the average on the number of ewes put to the ram and the number of lambs reared, or perhaps tailed. This is the only sensible basis upon which to work out the average, but other breeders either count only those ewes which lamb or the lambs which are born alive, taking no account of subsequent losses; both these methods are unsatisfactory.

It will be as well to make comments on the breed information using the same headings as those used later under the present heading.

GENERAL. Sundry information of general interest.

DISTRICTS. Here are given the districts where the breed is most commonly found. Flocks may be found in many other districts, but only in comparatively small numbers.

RUN ON ARABLE OR GRASS. When a breed is shown as "arable" or "grass" the usual practice is meant. All "arable" breeds can be run on grass and most "grass" breeds can be fed on arable if circumstance demand it.

EXPORTS. This informat on gives only a general idea of the countries to which the breed has been sent. "Canada" in one breed may mean

hundreds of sheep and in another breed perhaps only one or two rams.

Distinguishing Features. Unfortunately, in a brief description, a large number of breeds sound exactly alike.

Other Breeds used in Development. Some breed societies state that development has been entirely by selection within an existing local breed. Where this is the case the tables state " None."

Fleece Weight. A matter of considerable argument and one upon which there is little definite information.

Quality of Wool. The finer the wool the more hanks (560 yards) can be spun from one pound of scoured wool. The quality is expressed as the number of hanks which can be spun from 1 lb., hence 40's, 36's and so on.

Diameter of Fibre. Percentage of Black Fibres and Percentage of Kemp. These particulars are taken from information given in the *Young Farmer* (Professor Alfred F. Barker, June 1931). No subsequent information is available, so far as the author knows. Changes may have taken place in recent years but the figures given are at least comparable between breeds.

Breed: BLACK WELSH MOUNTAIN.
Classification: Mountain.
General: The only black breed of British sheep. Good quality mutton.
Districts where found: Few flocks, but scattered over England and Wales.
Run on Arable or Grass: Chiefly grass.
Exports: Tanganyika.
Usual crosses: Usually pure. Otherwise mated to down breeds for lamb or mutton.
Distinguishing features: Horns in rams only. Forehead free from wool, below knee and hock. Black all over.
Date of flock book: 1922.
Other breeds used in development: Built up by selection from black sheep in Welsh Mountain flock.
Mated in: August–October.
Lambs in: January–March.
Usual method of selling lambs: Fat and store lambs.
Fleece weight: 4 lb.
Uses of wool: Can be used undyed for a variety of dark clothes.
On *Quality of wool, diameter of fibres, percentage of black fibres, and percentage of kemp*, no official data are available.
Breed Society: Major F. H. I. Jervoise, Harriard Park, Basingstoke, Hants.

Breed: BORDER LEICESTER.
Classification: Longwool.
General: Tends to become too fat when pure bred but this is being improved. Ewes frequently crossed with down breeds. Rams excellent sires of cross-bred breeding ewes.
Districts where found: Counties either side of English and Scottish border.
Run on Arable or Grass: Either.
Exports: New Zealand, U.S.A., South Africa, Australia, Canada, South America.
Sales held at: Kelso, Ayr, Stirling, Aberdeen,

Fig. 3. Distribution of British Breeds of Sheep

Lanark, Perth, Carlisle, Belfast, Glasgow, Oswestry and Rothwell.
Usual crosses: Rams mated with Cheviot produce the Half-Bred ewe. Rams mated with S. Blackface produce the Greyface Ewe.
Distinguishing features: Roman nose. White face. No forelock and no wool in front of ears. Clean white legs with no wool below knee and hock. No horns.
Date of flock book: 1898.

Other breeds used in development: Descended from Bakewell's Leicesters.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat or store lambs.
Fleece weight: 9 lbs
Uses of wool: Dress fabrics, hosiery.
Quality of wool: 40 per cent 40's, 45 per cent 46's.
Diameter of fibres: 1/712 in.
Percentage of black fibres: 0.
Percentage of kemp: 1.
Breed Society: Miss R. J. E. Grant, 11, St. Ronans Terrace, Edinburgh, 10.

Breed: CHEVIOT.
Classification: Mountain.
General: Used on hill land, lower than that on which the Scotch Blackface runs. Only hand fed in severe weathers.

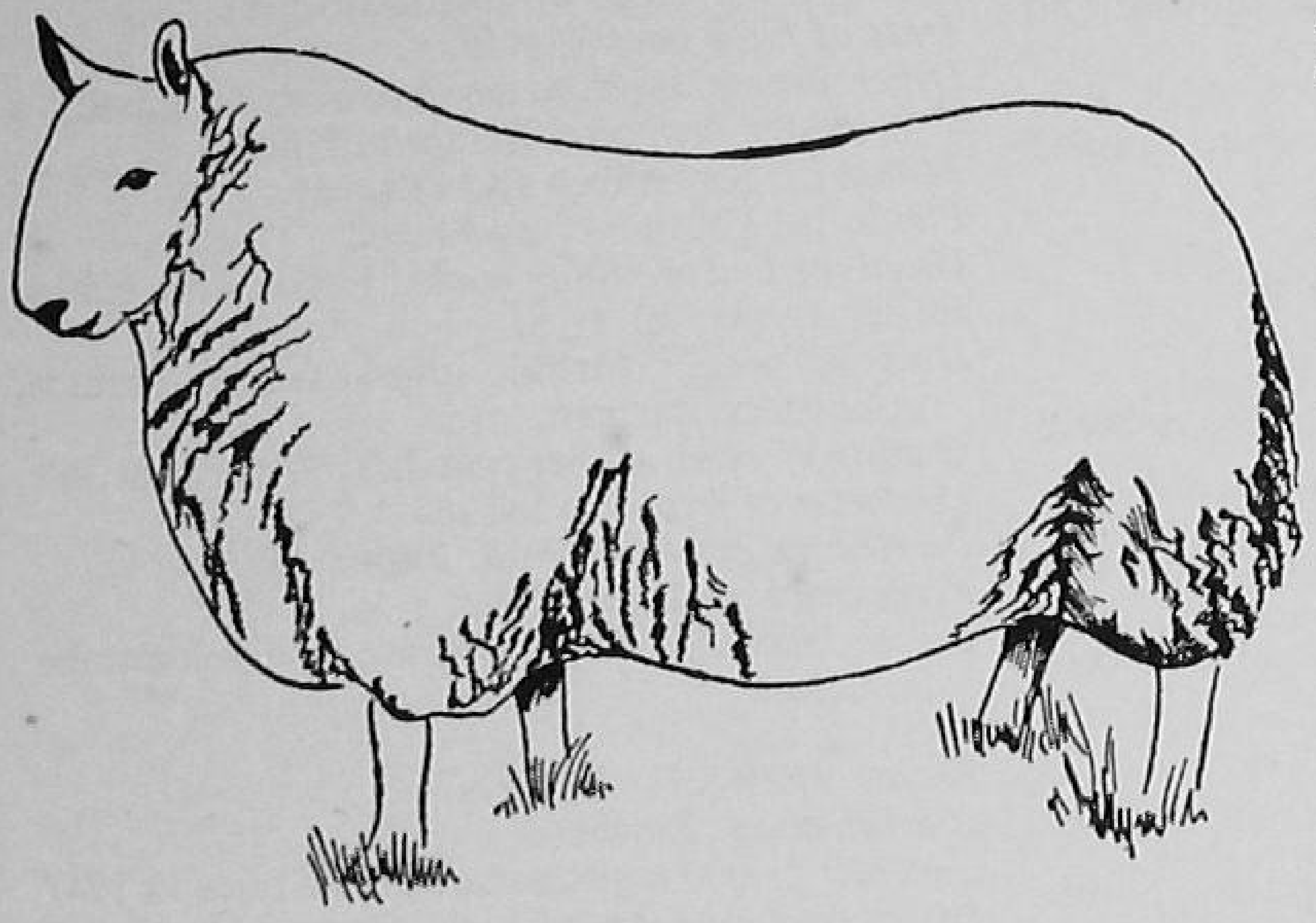


FIG. 4. CHEVIOT

Districts where found: Chiefly South Scotland and Northumberland.
Run on Arable or Grass: Grass.
Exports: Canada, Scandinavia, New Zealand, Falkland Isles, U.S.A., Africa and Argentine.
Sales held at: Hawick, Rothbury, Lodkierbie, St. Boswell and Annan.
Usual crosses: Ewes mated to Down breeds for mutton and to Border Leicester rams to produce the famous Half-Bred ewe.
Distinguishing features: White face, Roman nose, no wool in front of ears. White clean legs. No horns. Smaller than Border Leicester, but otherwise similar in appearance.
Date of flock book: 1891.
Other breeds used in development: None.
Mated in: Mid-November.
Lambs in: Mid-April.
Usual method of selling lambs: Store lambs, fat lambs and ewe lambs for breeding.
Fleece weight: 4–5 lb.
Uses of wool: Tweed, blankets, knitting wool.
Quality of wool: 10 per cent 28's, 12½ per cent 32's, 30 per cent 36's, 22 per cent 40's, 25 per cent 46's.
Diameter of fibres: 1/681 in.
Percentage of black fibres: 2.
Percentage of kemp: 3.
Breed Society: G. H. Armstrong, Commercial Bank Buildings, Hawick.

Breed: CLUN FOREST.
Classification: Down.
General: 360 registered flocks in 23 counties. Mentioned as far back as 1837. Adaptable to poor conditions, orchards, etc. 17,000 registered ewes.
Districts where found: Widely dispersed.
Run on Arable or Grass: Chiefly grass, but can be run on arable.
Exports: None reported.
Sales held at: Craven Arms, Ludlow, Clun, Leominster, Kington, Knighton and Hereford.
Usual crosses: Usually pure, but also crossed with Hampshire, Shropshire and Kerry Hill.
Distinguishing features: Dark-brown, face, forelock of white wool, dark legs, clean below knee and hock.
Date of flock book: 1925.
Other breeds used in development: None.
Mated in: October and November.
Lambs in: March and April.
Usual method in selling lambs: Fat lamb, store lambs and as tegs.
Fleece weight: 6 lb.
Uses of wool: Felt and yarns.
Quality of wool: Frequently graded as Shropshire.
Diameter of fibres: No information available.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: W. H. Wolley, Mill House, Craven Arms, Shropshire.

Breed: COTSWOLD.
Classification: Longwool.
General: Now unimportant. Breed numbers have fallen considerable.
Districts where found: Chiefly in Cotswolds on thin, chalky soils.
Run on Arable or Grass: Chiefly arable.
Exports: U.S.A., Germany and Canada.
Usual crosses: Ewes mated to a Down ram for mutton and lamb.
Distinguishing features: White face with heavy forelock. Legs white and woolled. No horns.
Date of flock book: 1891.

Other breeds used in development: None.
Mated in: August–November.
Lambs in: January–April.
Usual method of selling lambs: Fat or store lambs.
Fleece weight: 10 lb.
Uses of wool: Includes dress fabrics, braids, upholstery, carpets.
Quality of wool: 35 per cent 36's, 40 per cent 40's.
Diameter of fibres: 1/646 in.
Percentage of black fibres: None.
Percentage of kemp: None.

Breed: DARTMOOR.
Classification: Longwool.
General: Lambs are shorn in this breed. Usually run on poor land.
Districts where found: Devon, Cornwall.
Run on Arable or Grass: Chiefly grass.
Exports: South Africa, France, Canada, U.S.A.
Sales held at: South Brent and Tavistock.
Usual crosses: Mated to Down for mutton and lamb.
Distinguishing features: White face with grey markings. Forelock. Grey and white woolled legs. No horns.
Date of flock book: 1909.
Other breeds used in development: None.
Mated in: September and October.
Lambs in: February and March.
Usual method of selling lambs: Fat lambs or store lambs.
Fleece weight: 12 lb.
Uses of wool: Blankets, heavy woollens and carpets.
Quality of wool: 60 per cent 36's, 40 per cent 40's.
Diameter of fibres: 1/642 in.
Percentage of black fibres: 1.
Percentage of kemp: None.
Breed Society: S. J. S. Wakeham, Herboro, South Brent, Devon.

Breed: DEVON CLOSEWOOL.
Classification: Down.
General: Has been bred on the same farms for thirty years though its flock book is recent. This is the most recently founded British breed. 210 flocks are in existence.
Districts where found: Chiefly North Devon.
Run on Arable or Grass: Chiefly grass.
Exports: None reported.
Sales held at: Bratton Fleming, South Moulton, Barnstaple, Blackmoor Gate.
Usual crosses: Usually pure bred.
Distinguishing features: Face white with crown of head well covered. Legs white and woolled. No horns.
Date of flock book: 1923.
Other breeds used in development: Devon Long: wool × Exmoor Horn Cross.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat lamb and store lambs.
On *fleece weight, uses of wool, quality of wool, diameter of fibres, percentage of black fibres, percentage of kemp*, no official information is available.
Breed Society: F. J. Sanders, 94, High Street, Barnstaple, North Devon.

Breed: DEVON LONGWOOL.
Classification: Longwool.
General: This breed produced the heaviest carcase ever recorded (in 1846) of 228 lb.
Districts where found: Devonshire.
Run on Arable or Grass: Either.
Exports: Argentine and Australia.
Sales held at: Wiveliscombe and Tiverton.
Usual crosses: Ewes mated to Down ram for mutton or lamb.
Distinguishing features: Face white with forelock. No horns. Legs white and woolled.
Date of flock book: 1900.
Other breeds used in development: Originally a Leicester ram on a Bampton Nott.
Mated in: September and October.
Lambs in: February and March.
Usual method of selling lambs: Fat or store lambs.
Fleece weight: 10–11 lb.
Uses of wool: Include dress fabrics, braids, upholstery, carpets.
Quality of wool: 42 per cent 32's, 37 per cent 36's.
Diameter of fibres: 1/582 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: F. J. Morle, Wiveliscombe, Somerset.

Breed: DORSET DOWN.
Classification: Down.
General: 21,000 registered ewes and rams in 1947.
Districts where found: Chiefly Dorset, Hampshire and Somerset.
Run on Arable or Grass: Either.
Exports: Australia, France and Denmark.
Sales held at: Dorchester and Blandford.
Usual crosses: Ewes normally mated to Dorset Down. Rams used for crossing for mutton and lamb.
Distinguishing features: Greyish-brown face with forelock. Greyish-brown woolled legs.
Date of flock book: 1906.
Other breeds used in development: Originally a Southdown × Hampshire Cross.
Mated in: August, September and October.
Lambs in: January, February and March.
Usual Method of selling lambs: Fat lamb, mutton and rams for crossing.
Fleece weight: 5 lb.
Uses of wool: Flannels, felts, hosiery and dress fabrics
Quality of wool: 30 per cent 50's, 65 per cent 56's.
Diameter of fibres: 1/651 in.
Percentage of black fibres: None.

Percentage of kemp: None.
Breed Society: F. K. Ryan, 20, South Street, Dorchester, Dorset.

Breed: DORSET HORN.
Classification: Down.
General: Can be bred from twice in twelve months but this is not usual practice. Ewes come ' on heat ' throughout the year, with the exception of a month or two in early summer. Ewes in 1946 flock book, 20,093.
Districts where found: Chiefly South England, Isolated flocks widely scattered.
Run on Arable or Grass: Arable or grass.
Exports: U.S.A., Canada, Trinidad, New Zealand, Australia.
Sales held at: Dorchester, Poundbury and Isle of Wight.
Usual crosses: Ewes usually mated to a Down ram for fat lamb production.
Distinguishing features: White face with pink nostrils. White legs. Horns in ram and ewe.
Date of flock book: 1891.
Other breeds used in development: None.
Mated in: April–August.
Lambs in: September–January.
Usual method of selling lambs: Fat lamb.
Fleece weight: 6 lb.
Uses of wool: Flannels, felts, hosiery and dress fabrics.
Quality of wool: 42 per cent 50's, 42 per cent 56's.
Diameter of fibres: 1/658 in.
Percentage of black fibres: None.
Percentage of kemp: 1.
Breed Society: J. Dean Smith, Dorchester, Dorset.

Breed: EXMOOR.
Classification: Mountain.
General: Usually found on the high lands of the West Country. Hardy and economical to feed.
Districts where found: Chiefly West Somerset and North Devon.
Run on Arable or Grass: Grass.
Exports: None recorded.
Sales held at: Exford, Molland and Blackmoor Gate.
Usual crosses: Mated to Down rams for mutton and lamb.
Distinguishing features: White face with close forelock. White woolled legs. Horns in both sexes. Black nostrils.
Date of flock book: 1907.
Other breeds used in development: None.
Mated in: September and October.
Lambs: February and March.
Usual method of selling lambs: Fat lamb or mutton.
Fleece weight: 5 lb.
Uses of wool: No information available.
Quality of wool: 40 per cent 40's, 36 per cent 46's, 22 per cent 50's.
Diameter of fibres: 1/692 in.
Percentage of black fibres: None.
Percentage of kemp: 1.
Breed Society: W. E. Yendell, Castle Cot, Bratton Fleming, North Devon.

Breed: GREYFACE.
Classification: Cross between Longwool (Border Leicester) and Mountain (Scotch Blackface).
General: Very prolific, but somewhat variable in appearance and with variable wool. Not so variable in appearance as the Masham. Usually cheaper to buy than the Half-Bred.
Districts where found: Scotland, North England and widely distributed.
Run on Arable or Grass: Chiefly grass.
Exports: None.
Sales held at: Widely in the North of England and Scotland.
Usual crosses: Mated to Down rams for fat and store lamb production.
Distinguishing features: Slightly Roman nose. Face and legs white, grey or speckled. Horns occasionally. Very variable.
Other breeds used in development: Border Leicester. Scotch Black face Cross.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat or store lamb.
Fleece weight: 6–7 lb.
Uses of wool: Includes carpets, tweeds, hosiery, linings.
Quality of wool, diameter of fibres, percentage of black fibres, percentage of kemp, are very variable. A good estimate can be made by examining the wool data of the two parent breeds.
Note: There is no society associated with this well known cross.

Breed: HALF-BRED.
Classification: Cross between Longwool (Border Leicester) and Mountain (Cheviot). Formerly produced from old Cheviot ewes, but more recently from Cheviot ewes of all ages owing to great demand for progeny. Can be produced by mating a Half-Bred ram with Half-Bred ewes.
General: Very prolific. Uniform in appearance owing to the similar white faces and legs of the two parents. Varies in size and wool.
Districts where found: Widely distributed over British Isles.
Run on Arable or Grass: Chiefly grass.
Exports: None recorded.
Sales held at: St. Boswells, Aberdeen, Hawick.
Usual crosses: Mated to Down ram for fat or store lamb production
Distinguishing features: Roman nose. White face with no wool in front of ears. No forelock. Clean white legs. No wool below knee or hock. No horns.
Other breeds used in development: Border Leicester × Cheviot cross.

Mated in: October or November.
Lambs in: March or April.
Usual method of selling lambs: Fat or store lambs.
Fleece weight: 7 lb.
Uses of wool: Dress fabrics, tweeds, hosiery and knitting yarns.
The quality of wool, diameter of fibres, percentage of black fibres, and *percentage of kemp* are variable. A general idea of the wool quality can be gained by studying the wool data of the parent breeds.
Note: This cross has no society.

Breed: HAMPSHIRE.
Classification: Down.
General: Produces good quality mutton and wool. Ram breeding flocks lamb in January, others later.
Districts where found: Southern England.
Run on Arable or Grass: Either, but notably arable.
Exports: Almost worldwide. Since war to Czechoslovakia.
Sales held at: Tring, Weyhill, Salisbury, Wilton, Marlborough and Westbury.
Usual crosses: Ewes normally to Hampshire. Rams used with many breeds for mutton and lamb.
Distinguishing features: Dark-brown face and knees. Face largely covered with wool. Forelock. No horns.
Date of flock book: 1890.
Other breeds used in development: Originally Wiltshire × Berkshire Nott.
Mated in: August, September and October.
Lambs in: January, February and March.
Usual method of selling lambs: Fat lamb, ram lambs and ram tegs.
Fleece weight: 5 lb.
Uses of wool: Hosiery, flannels and felts.
Quality of wool: 10 per cent 50's, 90 per cent 56's.
Diameter of fibres: 1/737 in.
Percentage of black fibres: 7.
Percentage of kemp: None.
Breed Society: The Secretary, 49, Canal, Salisbury.

Breed: HERDWICK.
Classification: Mountain.
General: Very hardy. Reputed to be descended from forty sheep landed from a wrecked Spanish vessel. The lambs are wintered on low ground.
Districts where found: Lake District.
Run on Arable or Grass: Grass.
Exports: None recorded.
Sales held at: Boot, Keswick and Eskdale.
Usual crosses: Mated to Herdwick rams on the mountains but draft ewes after four crops of lambs are mated to Down and Longwool rams on the lowlands.
Distinguishing features: Grey or white face. Horns in ram only.
Date of flock book: 1916.
Other breeds used in development: None.
Mated in: November and December.
Lambs in: April and May.
Usual method of selling lambs: Fat lamb late in summer or as store lambs.
Fleece weight: 4 lb.
Uses of wool: Carpets and tweeds.
Quality of wool: 60 per cent 28's, 40 per cent 32's.
Diameter of fibres: 1/525 in.
Percentage of black fibres: 30.
Percentage of kemp: 20.

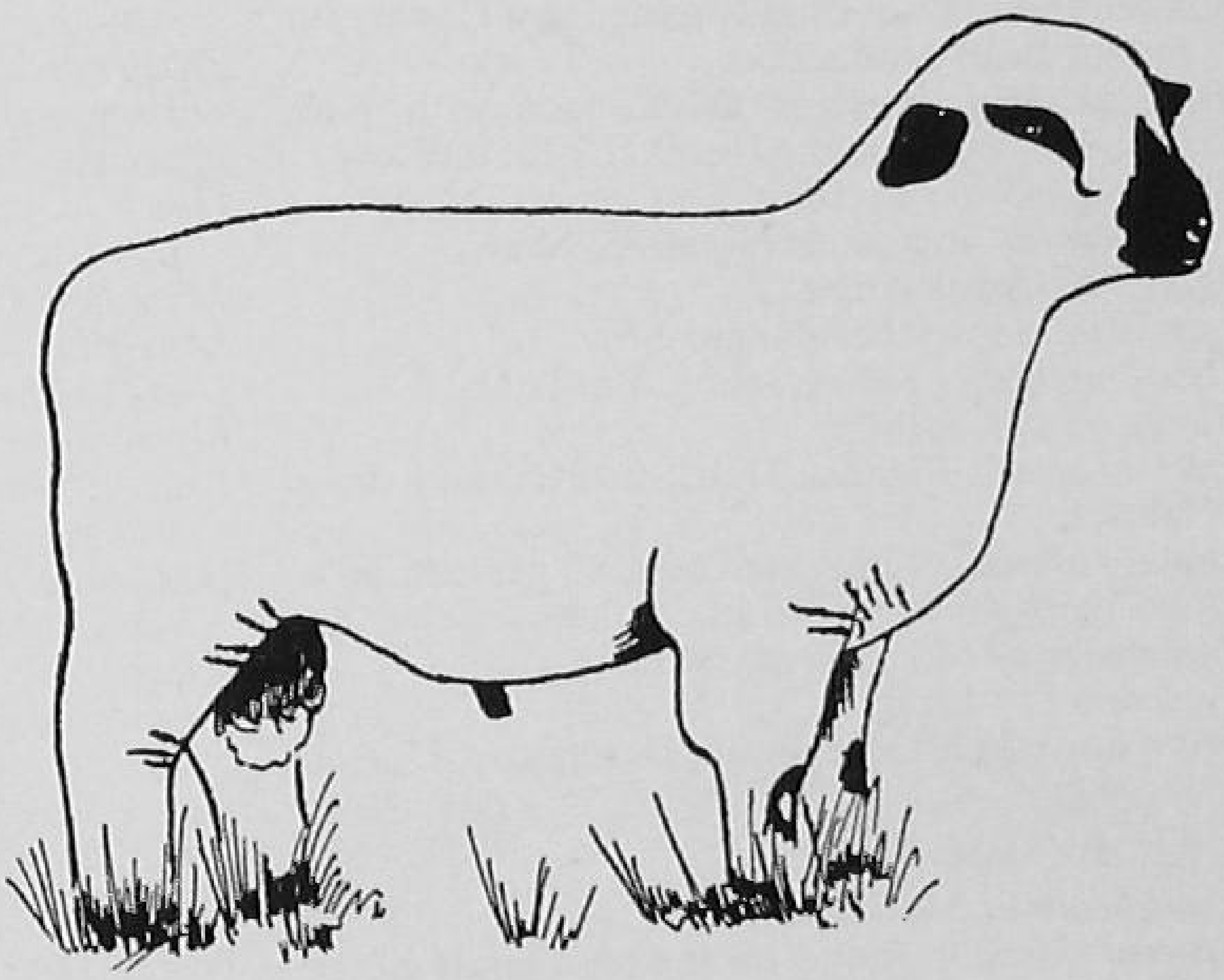


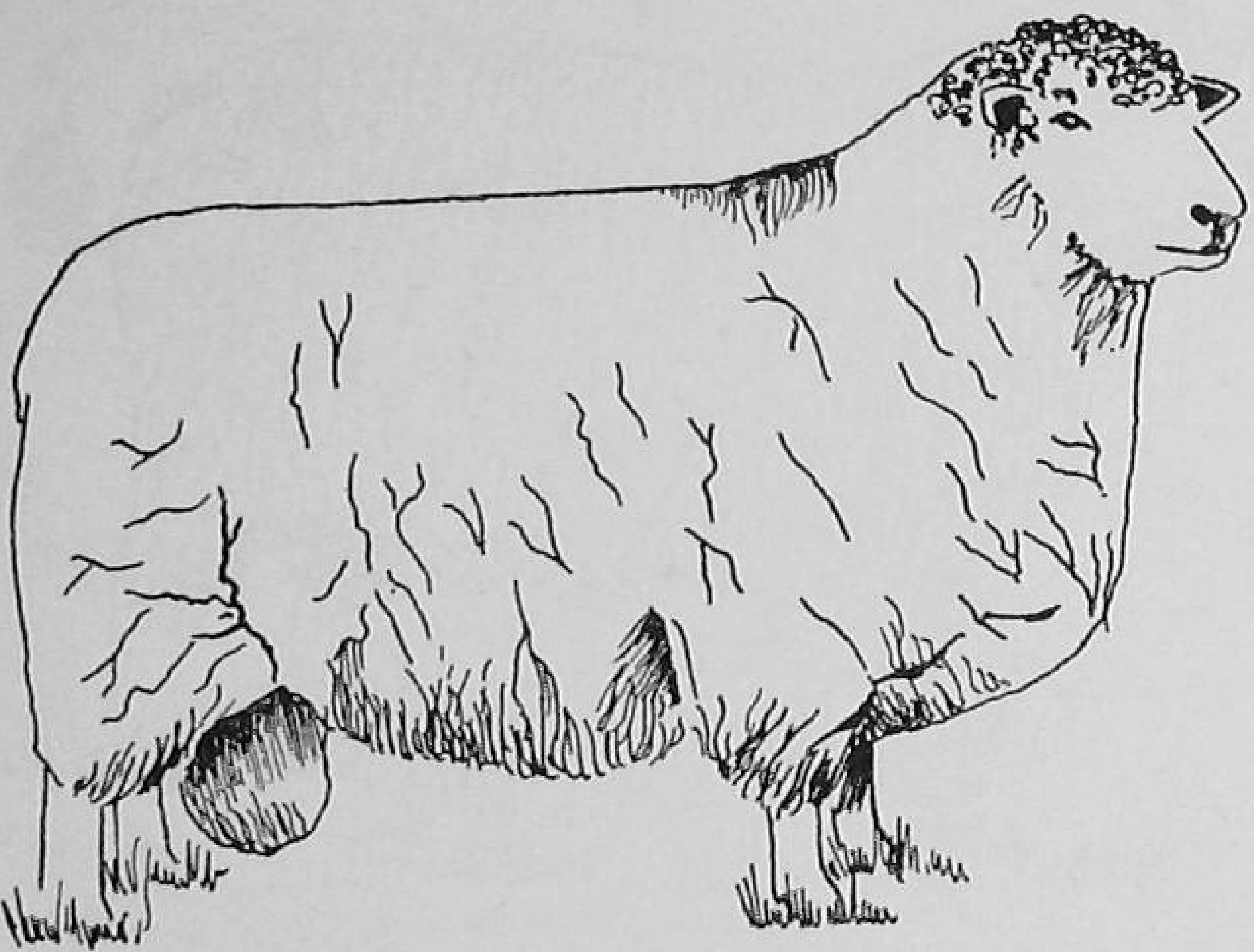
Fig. 5. Hampshire Down

Breed Society: The Secretary, Brownrigg, Caldbeck, Wigton.

Breed: KENT or ROMNEY MARSH.
Classification: Longwool.
General: Frequently mated to Down ram for mutton and lamb. The characteristic breed of the Romney Marsh area of Kent. Prices up to 1,000 guineas have been realized for rams.
Districts where found: South-east England, especially Kent.
Run on Arable or grass: Chiefly grass.
Exports: Almost worldwide. The primary breed of New Zealand.
Sales held at: Ashford (Kent), and Maidstone.
Usual crosses: Ewes mated to Down ram for mutton and lamb. Rams used mainly on Kent ewes.
Distinguishing features: White face with forelock

of wool. No horns. Legs white and woolled.
Date of flock book: 1895.
Other breeds used in development: A little Leicester blood was at one time introduced.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat lamb, store lambs and tegs.
Fleece weight: 8 lb.
Uses of wool: Dress fabrics.
Quality of wool: 44 per cent 40's, 41 per cent 46's.
Diameter of fibres: 1/701 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: The Secretary, Victoria House, Southampton Row, London, W.C.1.

Breed: KERRY HILL.
Classification: Down.



KENT OR ROMNEY MARSH
FIG. 6.

General: Mentioned as distinct breed in 1809. 194 registered flocks.
Districts where found: Registered flocks in twenty-five counties of England and Wales.
Run on Arable or Grass: Chiefly grass.
Exports: South Africa, U.S.A., Canada, France, Belguim, Eire, New Zealand.
Sales held at: Knighton, Kerry and Craven Arms.
Usual crosses: Ewes mated frequently to Southdown, etc., for lamb production. Rams sometimes crossed with Welsh Mountain ewes.
Distinguishing features: Tail frequently left long. Face white, speckled with black spots and legs ditto. Forelock. No horns.
Date of flock book: 1899.
Other breeds used in development: Originally Shropshire × Radnor Forest cross.
Mated in: October or November.
Lambs in: March or April.
Usual method of selling lambs: Fat lamb or mutton.
Fleece weight: 6 lb.
Uses of wool: Felts, tweeds and knitting wool.
Quality of wool: 40 per cent 36's, 33 per cent 40's, 27 per cent 46's.
Diameter of fibres: 1/714 in.
Percentage of black fibres: None.
Percentage of kemp: 1.
Breed Society: Messrs. Morris, Marshall and Poole, High Street, Newtown.

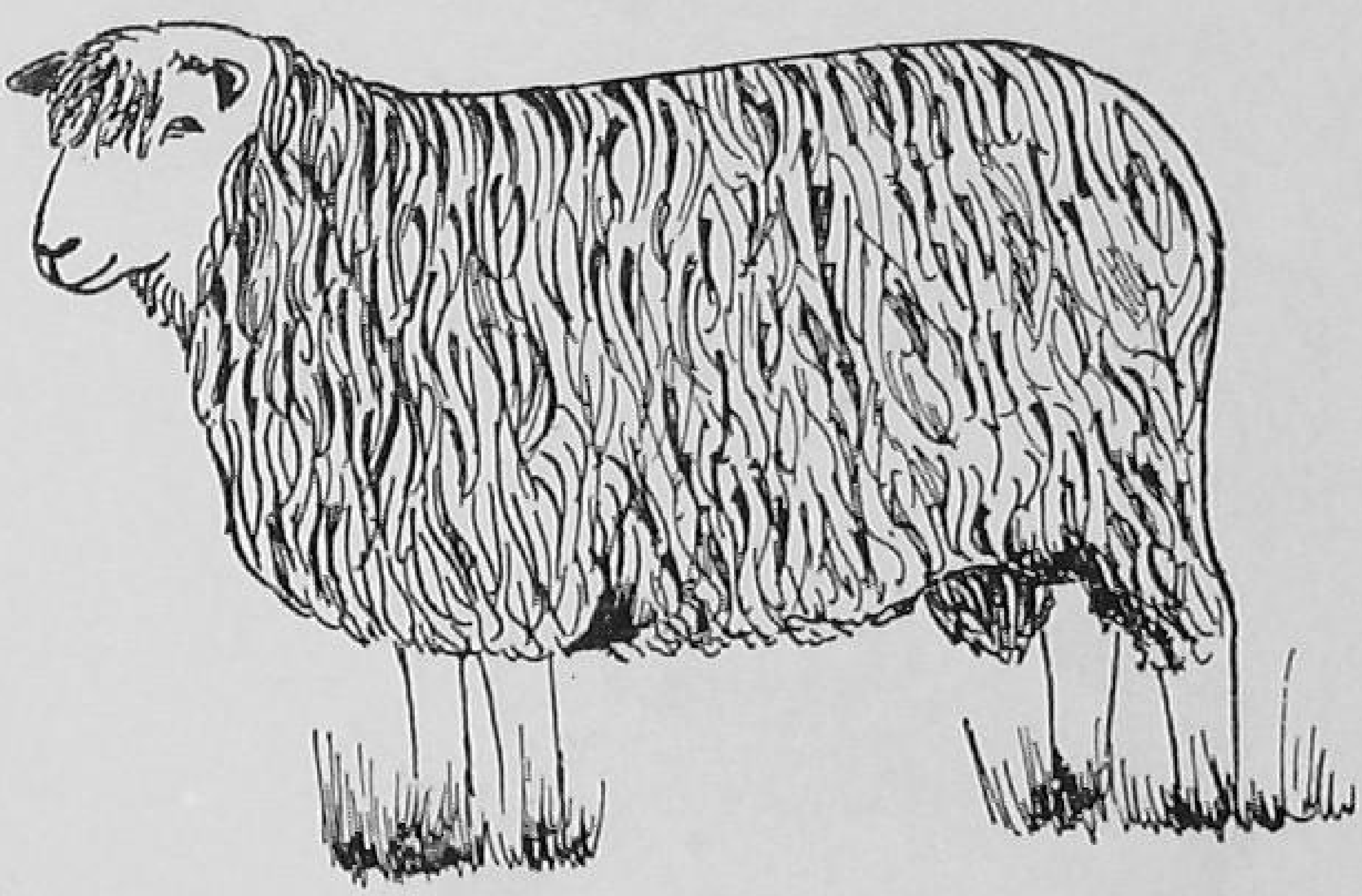
Breed: LEICESTER.
Classification: Longwool.
General: Pure bred carcases at one time too fat are now being bred thinner. Usually crossed with one of Down breeds. Pioneer breeder Bakewell of Dishley. Ninety registered flocks in Australia.
Districts where found: Yorkshire, Durham, Lancashire, Cumberland, Westmorland.
Run on Arable or Grass: Either.
Exports: New Zealand, U.S.A., Australia, France, Canada, Holland, Denmark, South Africa and Sweden.
Sales held at: Duffield, Seamer, York, Malton, Market Weighton.
Usual crosses: Ewes mated to Down ram for mutton or lamb production.
Distinguishing features: No horns. White face with forelock. Legs white and well woolled.
Date of flock book: 1893.
Other breeds used in development: None.
Mated in: October or Nvoember.
Lambs in: March or April.
Usual method of selling lambs: Fat lamb or from arable folds 7–11 months old.
Fleece weight: 10 lb.
Uses of wool: Dress fabrics, hosiery, linings, and roller wrappings.
Quality of wool: 45 per cent 40's, 45 per cent 46's.
Diameter of fibres: 1/614 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: C. H. Simpson, Hunmanby, Yorkshire.

Breed: LINCOLN.
Classification: Longwool.
General: Decreasing in importance since the reduction in arable sheep. Recognized as a pure breed since about 1750. The heaviest breed of British sheep, producing also the heaviest fleece. 50,000 registered ewes.
Districts where found: Chiefly Lincolnshire and Leicestershire.

Run on Arable or Grass: Chiefly arable.
Exports: Almost world-wide. The predominating breed of Argentine.
Sales held at: Brigg, Lincoln, Stamford, Newark, Peterborough, Louth, Horncastle.
Usual crosses: Ewes mated to a Down ram for mutton and lamb.
Distinguishing features: White face with heavy forelock. No horns. Legs white and woolled.
Date of flock book: 1892.
Other breeds used in development: Leicester.
Mated in: September and October.
Lambs in: February and March.
Usual method of selling lambs: Fat lamb or mutton.
Fleece weight: 11 lb. A two-shear ram once clipped 46½ lb. of greasy wool.
Uses of wool: Dress fabrics, braids, carriage upholstery, carpets and roller wrappings.
Quality of wool: 40 per cent 36's, 45 per cent 40's.
Diameter of fibres: 1/552 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: F. P. Taylor, 184, High Street, Lincoln.

Breed: LONK.
Classification: Mountain.
General: Seldom hand fed. Very hardy.
Districts where found: Hills of East Lancashire and South or South-west Yorkshire.
Run on Arable or Grass: Grass.
Exports: A few to Austria and U.S.A.
Usual crosses: Often mated to Down rams for mutton and lamb.
Distinguishing features: Black and white face and legs. Horns in male and female.
Date of flock book: 1905.
Other breeds used in development: Possibly Scotch Blackface.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat lamb or store lamb.
Fleece weight: 5–6 lb.
Uses of wool: Tweeds, blankets, carpets.
Quality of wool: 19 per cent 32's, 36 per cent 36's, 45 per cent 40's.
Diameter of fibres: 1/620 in.
Percentage of black fibres: 12.
Percentage of kemp: None.
Breed Society: H. P. Airey, Estate Office, Whalley, Blackburn, Lancashire.

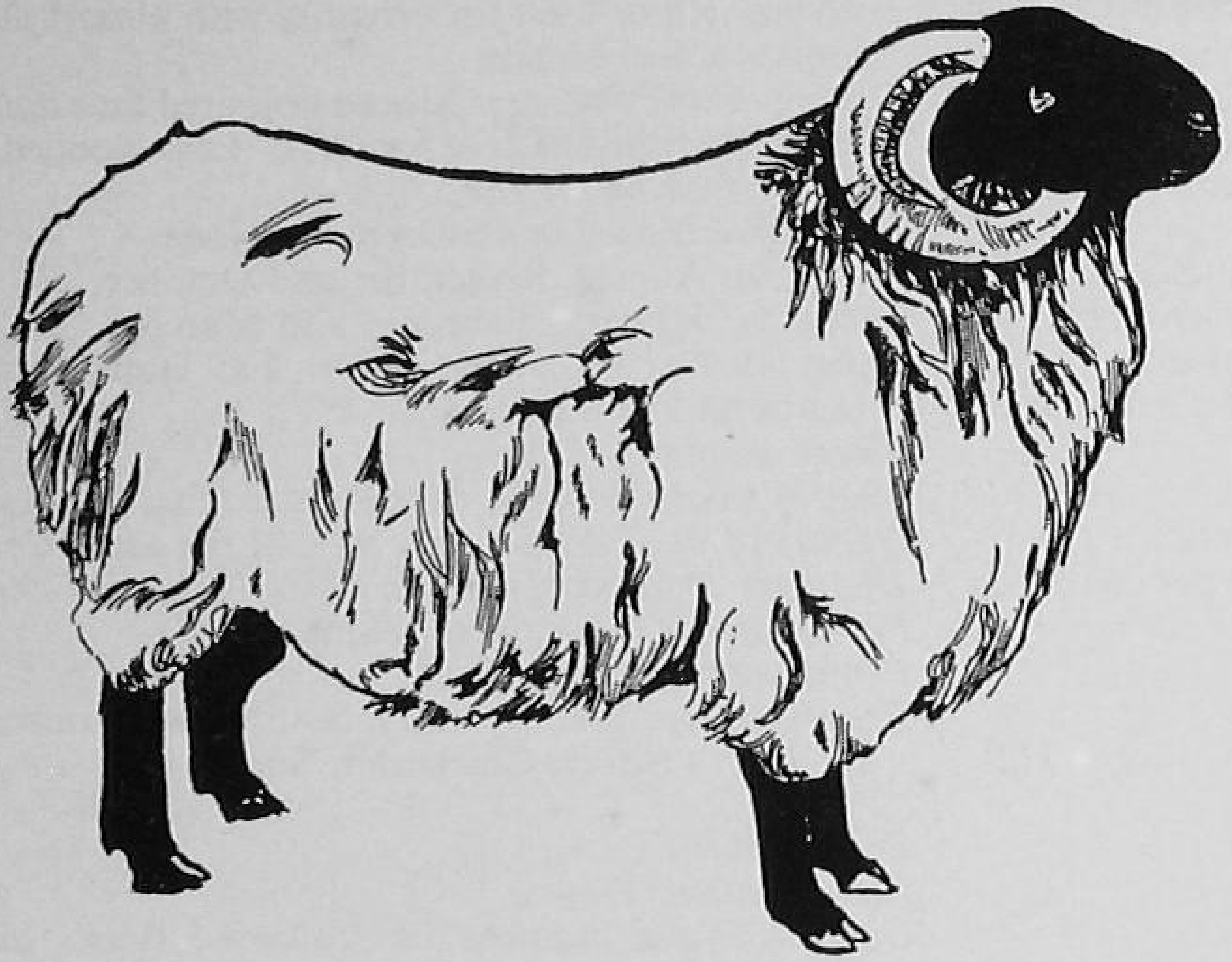
Breed: MASHAM.
Classification: Produced by a cross between Longwool (Wensleydale) and Mountain (Scotch Blackface or Swaledale).
General: Very prolific but very variable in appearance and with very variable wool. Hardier than the Half-Bred and will live on poorer keep.
Districts where found: North of England and fairly widespread over the country.
Run on Arable or Grass: Grass.
Exports: None.
Sales held at: Widespread in the North.
Usual crosses: Mated to Down rams for fat lamb and store lambs.
Distinguishing features: Black, almost white or speckled face and legs. Forelock of wool.
Date of flock book: None.
Other breeds in used in development: Wensleydale ram mated to Scotch Blackface or Swaledale ewes.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat lamb or store lamb.
Fleece weight: 6 lb.
Uses of wool: Include carpets, tweeds, hosiery and linings.
Quality of wool: Very variable from the coarse wool of the Blackface to the lustrous wool of the Wensleydale.
Diameter of fibres, percentage of black fibres, and *percentage of kemp* is very variable. A good estimate can be made by examining the wool data of the two parent breeds.
Note: There is no Society associated with this cross.



ENGLISH LEICESTER
FIG. 7.

Breed: OXFORD.
Classification: Down.
General: The largest of the Down breeds in size and one of the largest of the British breeds. Early maturing. 7,166 ewes in 1946 flock book.

Districts where found: Oxford, surrounding counties and some other counties of England and Scotland.
Run on Arable or Grass: Either, but notably arable.
Exports: Almost world-wide.
Sales held at: Oxford, Kelso and Cirencester.
Usual crosses: Ewes usually to an Oxford. Rams to many breeds for mutton and lamb, chiefly in the north.
Distinguishing features: Dark-brown face with large forelock. Legs brown and woolled. No horns. Breeders are aiming now at a darker face.
Date of flock book: 1888.
Other breeds used in development: Originally Hampshire × Cotswold.
Exports: New Zealand, Canada, U.S.A., South Africa, Argentine and Europe.
Sales held at: Hereford and Reading.
Usual crosses: Ewes usually mated to Ryeland. Rams used for crossing with other breeds for mutton and lamb.
Distinguishing features: White woolled face with close forelock. No horns.
Date of flock book: 1910.
Other breeds used in development: Cotswold and Leicester.
Mated in: August, September and October.
Lambs in: January, February and March.
Usual method of selling lambs: Fat lamb, store lambs, ram lambs and ram tegs.
Fleece weight: 7 lb.
Uses of wool: Hosiery, knitting yarns and felts.
Quality of wool: 30 per cent 40's, 30 per cent 46's, 30 per cent 50's.
Diameter of fibres: 1/741 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: W. H. Woodcock, 45, Whitecross Road, Hereford.



SCOTCH BLACKFACE
FIG. 8.

Mated in: August–November.
Lambs in: January–April.
Usual method of selling lambs: Fat lamb, mutton, ram lambs and tegs.
Fleece weight: 8 lb.
Uses of wool: Include hosiery, knitting yarns, felts.
Quality of wool: 52 per cent 50's, 40 per cent 56's.
Diameter of fibres: 1/700 in.
Percentage of black fibres: 10.
Percentage of kemp: None.
Breed Society: Messrs. Maxwell and Stilgoe, Banbury, Oxfordshire.

Breed: RYELAND.
Classification: Down.
General: 60–70 pedigree flocks in this country.
Districts where found: Chiefly in Hereford area.
Run on Arable or Grass: Arable or grass.

Breed: SCOTCH BLACKFACE.
Classification: Mountain.
General: Will live on very poor fare. Practically never hand fed. Very hardy. Small carcase of very good flavoured mutton. Lamb average 75 per cent upwards according to district and severity of the winter. Ram lambs have been sold for £2,000.
Districts where found: Moorlands and mountains of north of England and Scotland.
Run on Arable or Grass: Grass or moorland.
Exports: Argentine, U.S.A., Italy.
Sales held at: Ayr, Perth, Stirling, Newton Stewart, Lanark and Oban, Peebles, Barrhill and Inverness.
Usual crosses: Ewes often mated to Border Leicester to produce Greyface ewes, or to Wensleydale to produce Masham ewes.
Distinguishing features: Face black or black and white. Legs similar almost hidden by the long wool when fleece is fully grown. Horns in both sexes.
Date of flock book: 1901.
Other breeds used in development: None.
Mated in: November and December.
Lambs in: April and May.
Usual method of selling lambs: Fat lamb, store lamb or for breeding.
Fleece weight: 4½ lb.
Uses of wool: Tweeds, carpets, upholstery and mattresses.
Quality of wool: 30 per cent low, 50 per cent 28's, 20 per cent 32's.

Diameter of fibres: 1/469 in.
Percentage of black fibres: 14.
Percentage of kemp: 15.
Breed Society: G. D. Cheyne, 32, Rutland Square, Edinburgh, 1.

Breed: SHROPSHIRE.
Classification: Down.
General: Good quality wool and mutton.
Districts where found: Chiefly Shropshire and neighbouring counties.
Run on Arable or Grass: Either.
Exports: Almost world-wide. Since the war to U.S.A. and Canada.
Sales held at: Craven Arms, Dublin, Shrewsbury, Bridgnorth, Lichfield, Wellington, Birmingham, Newport, Shifnal.
Usual crosses: Ewes usually mated to Shropshire. Rams mated to various breeds for mutton and lamb.
Distinguishing features: Face black, with white wool on cheeks and forehead. Legs black with white wool often almost to ground. No horns.
Date of flock book: 1882.
Other breeds used in development: Southdown.
Mated in: August, September and October.
Lambs in: January, February and March.
Usual method of selling lambs: Fat lamb, tegs, ram lambs and ram tegs.
Fleece weight: 7 lb.
Uses of wool: Hosiery, felts and flannel.
Quality of wool: 52 per cent 50's, 40 per cent 56's.
Diameter of fibres: 1/817 in.
Percentage of black fibres: 3.
Percentage of kemp: None.
Breed Society: The Secretary, College Hill, Shrewsbury, Shropshire.

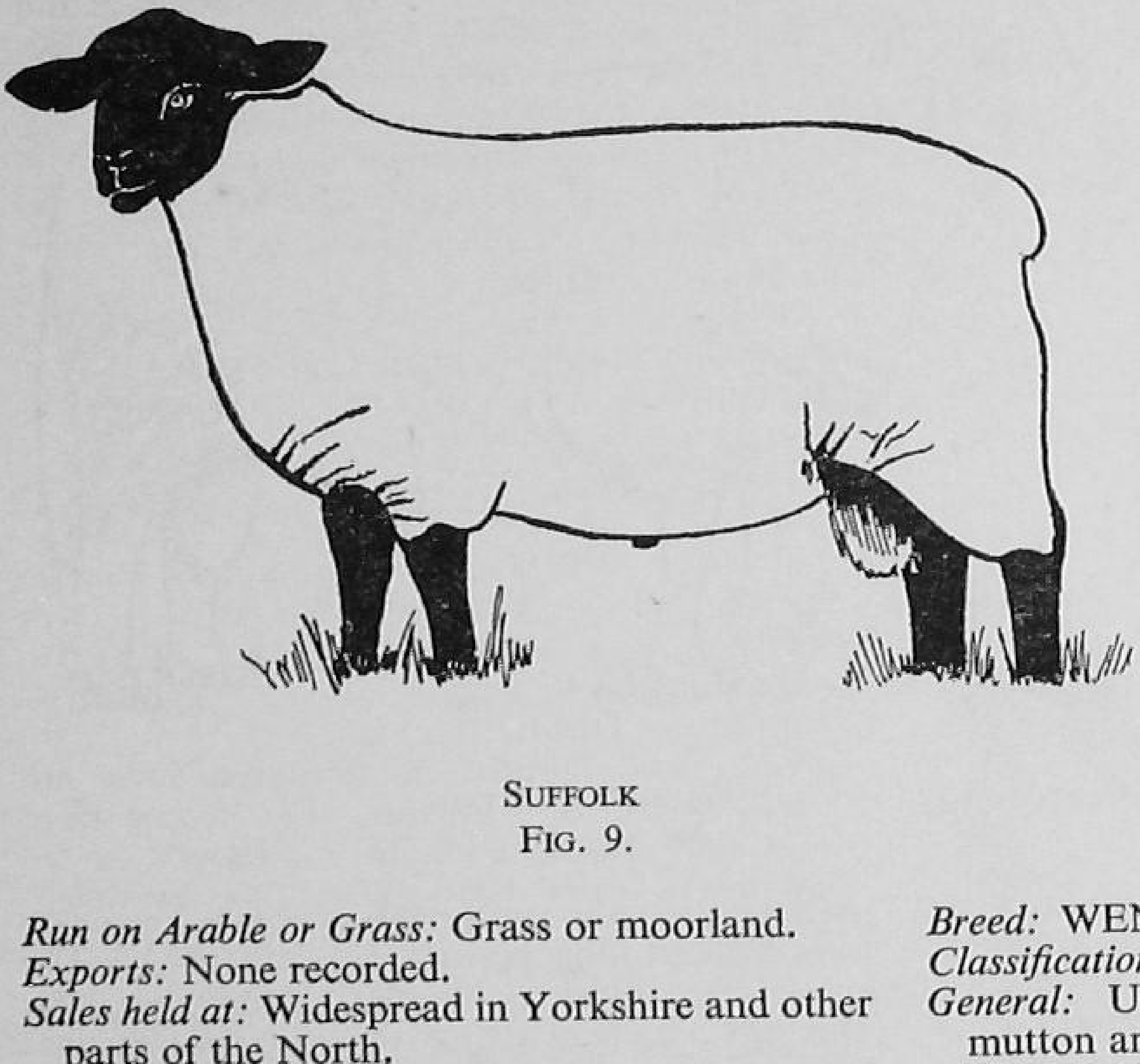
Breed: SOUTH DEVON.
Classification: Longwool.
General: Capable of reaching great weights both of mutton and wool.
Districts where found: Devon and Cornwall.
Run on Arable or Grass: Either.
Exports: South Africa and Argentine.
Sales held at: Totnes, Kingsbridge, Truro, Liskeard, and South Brent.
Usual crosses: Ewes mated to Down ram for mutton and lamb.
Distinguishing features: Face white with forelock. No horns. Legs white and woolled. Curly wool.
Date of breed book: 1903.
Other breeds used in development: Probably none.
Mated in: September and October.
Lambs in: February and March.
Usual method of selling lambs: Fat or store lambs.
Fleece weight: 12 lb.
Uses of wool include: Dress fabrics, braids, upholstery, carpets, serges and blankets.
Quality of wool: 40 per cent 36's, 45 per cent 40's.
Diameter of fibres: 1/594 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: W. G. Powlesland, Dorma, Trelawny Road, Plympton, Devon.

Breed: SOUTHDOWN.
Classification: Down.
General: Produces the finest quality of mutton and wool of any British breed. Early maturing. John Ellman of Glynde was the pioneer breeder in the late 18th century. Official lamb average 126 per cent. 18,000 registered sheep.
Districts where found: South and Midlands, especially Sussex.
Run on Arable or Grass: Either.
Exports: Almost world-wide. The most important fat lamb producing sire in New Zealand.
Sales held at: Chichester and Lewes.
Usual crosses: Ewes normally mated to a Southdown. Rams used for crossing with almost all long-woolled breeds.
Distinguishing features: Mouse-coloured face and legs. No horns. Close forelock. Legs woolled.
Date of flock book: 1892.
Other breeds used in development: None.
Mated in: August, September and October.
Lambs in: January, February and March.
Usual method of selling lambs: Fat lamb, ram lambs and ram tegs.
Fleece weight: 4–5 lb.
Uses of wool: Hosiery, flannels and felts.
Quality of wool: 19 per cent 50's, 81 per cent 56's.
Diameter of fibres: 1/879 in.
Percentage of black fibres: None.
Percentage of kemp: None.
Breed Society: The Secretary, Southdown House, St. John's Street, Chichester, Sussex.

Breed: SUFFOLK.
Classification: Down.
General: Total number of registered flocks in Great Britain and Ireland, 415. Recognized as a pure breed since 1810. Flocks in 66 counties of British Isles. One of the few breed societies which officially records the lamb average of all flocks—130 per cent.
Districts where found: Flocks are found in 54 counties of the British Isles, but chiefly in East Anglia.
Run on Arable or Grass: Either, but notably arable.
Exports: Almost world-wide.
Sales held at: Kelso, Bury, Ipswich, Perth, Dublin, and Belfast.
Usual crosses: Ewes usually mated to a Suffolk, but occasionally to Southdown. Rams used for mating to many breeds for mutton and lamb.
Distinguishing features: Black face with no wool in front of ears. Clean black legs. No horns.
Date of flock book: 1886.
Other breeds used in development: Originally Southdown × Norfolk Horn.
Mated in: August, September and October.

Lambs in: January, February and March.
Usual method of selling lambs: Fat lamb or mutton.
Fleece weight: 6–7 lb.
Uses of wool: Dress fabrics, flannels, felts, hosiery, knitting wools and tweeds.
Quality of wool: 45 per cent 50's, 50 per cent 56's.
Diameter of fibres: 1/723 in.
Percentage of black fibres: 8 (1930 figure, subsequently improved).
Percentage of kemp: None.
Breed Society: The Secretary, 24, Princes Street, Ipswich, Suffolk.

Breed: SWALEDALE.
Classification: Mountain.
General: Very similar to Scotch Blackface in appearance and uses.
Districts where found: On hills and moors of Yorkshire, Pennines and Lake District.



SUFFOLK
FIG. 9.

Run on Arable or Grass: Grass or moorland.
Exports: None recorded.
Sales held at: Widespread in Yorkshire and other parts of the North.
Usual crosses: Mated to Wensleydale to produce the Masham ewe.
Distinguishing features: Black face with grey round muzzle. Black and white legs. Horns ram and ewe.
Date of flock book: 1920.
Other breeds used in development: None.
Mated in: November.
Lambs in: April.
Usual method of selling lambs: Fat lamb or mutton.
Fleece weight: 4–5 lb.
Uses of wool: Carpets and tweeds.
Quality of wool: 60 per cent 28's, 30 per cent 30's, 10 per cent 32's.
Diameter of fibres: 1/675 in.
Percentage of black fibres: 18.
Percentage of kemp: 12.
Breed Society: The Secretary, Winton House, Kirkby Stephen, Westmorland.

Breed: WELSH MOUNTAIN.
Classification: Mountain.
General: Good quality mutton. Very hardy. Draft ewes sold to lowland farms for fat lamb production as flying flocks. Very good quality mutton for very small carcases.
Districts where found: Mountains and hills of Wales.
Run on Arable or Grass: Grass.
Exports: U.S.A. and Canada.
Sales held at: Aberystwyth.
Usual crosses: Mated to Down rams for mutton and lamb production.
Distinguishing features: Slightlyt anned face, close forelock. Slightly tanned legs free from wool. Ram has horns, ewe has not.
Date of flock book: 1905.
Other breeds used in development: None.
Mated in: October and November.
Lambs in: March and April.
Usual method of selling lambs: Fat lamb or mutton.
Fleece weight: 2½ lb.
Uses of wool: Tweeds, blankets and carpets, according to the part of fleece from which it is taken.
Quality of wool: 10 per cent 28's, 10 per cent 32's, 46 per cent 36's, 34 per cent 40's.
Diameter of fibres: 1/592 in.
Percentage of black fibres: None.
Percentage of kemp: 7.
Breed Society: The Secretary, 1, Brynymor Terrace, Aberystwyth, Wales.

Breed: WENSLEYDALE.
Classification: Longwool.
General: Usually mated to Down rams for mutton and lamb. Prolific.
Districts where found: Yorkshire, Lancashire, Westmorland, Cumberland, and Scotland.
Run on Arable or Grass: Either.
Exports: South Africa, U.S.A. and Poland.
Sales held at: Hellifield, Northallerton, York and Leyburn.
Usual crosses: Mated to Scotch Blackface ewes to produce the Masham.
Distinguishing features: Blue colour in skin of face, legs and ears. Long, very lustrous wool, which is in little knots or 'pirls'. Forelock of wool on forehead.
Date of flock book: 1890.
Other breeds used in development: Originally Leicester rams on Teeswater ewes.
Mated in: October or November.

Lambs in: March or April.
Usual method of selling lambs: Fat or store lambs.
Fleece weight: 10 lb.
Uses of wool: Dress fabrics and hosiery.
Quality of wool: 40's–48's.
Diameter of fibres: 1/647 in.
Percentage of black fibres: 10.
Percentage of kemp: None.
Breed Society: J. B. Walker, Vailima, Kemp Bank Road, Grange-over-Sands, North Lancashire.

Breed: WILTSHIRE HORN.
Classification: Down.
General: Produces practically no wool.
Districts where found: Midlands, Anglesey, North Wales.
Run on Arable or Grass: Grass.
Exports: Kenya and Rhodesia.
Sales held at: Llangefni (Anglesey) and Northampton.
Usual crosses: Ewes mated to Wiltshire Horn. Rams mated to many longwools for fat lamb production and to cross-bred ewes, Cluns, Kerrys and Welsh ewes.
Distinguishing features: Practically no wool. White face and legs. Horns in both sexes.
Other breeds used in development: Native of Wiltshire.
Mated in: September and October.
Lambs in: February and March.
Usual method of selling lambs: Fat lambs.
The breed produces practically no wool, hence no wool data are available.
Breed Society: J. F. Reid, 162, Ardington Road, Northampton.

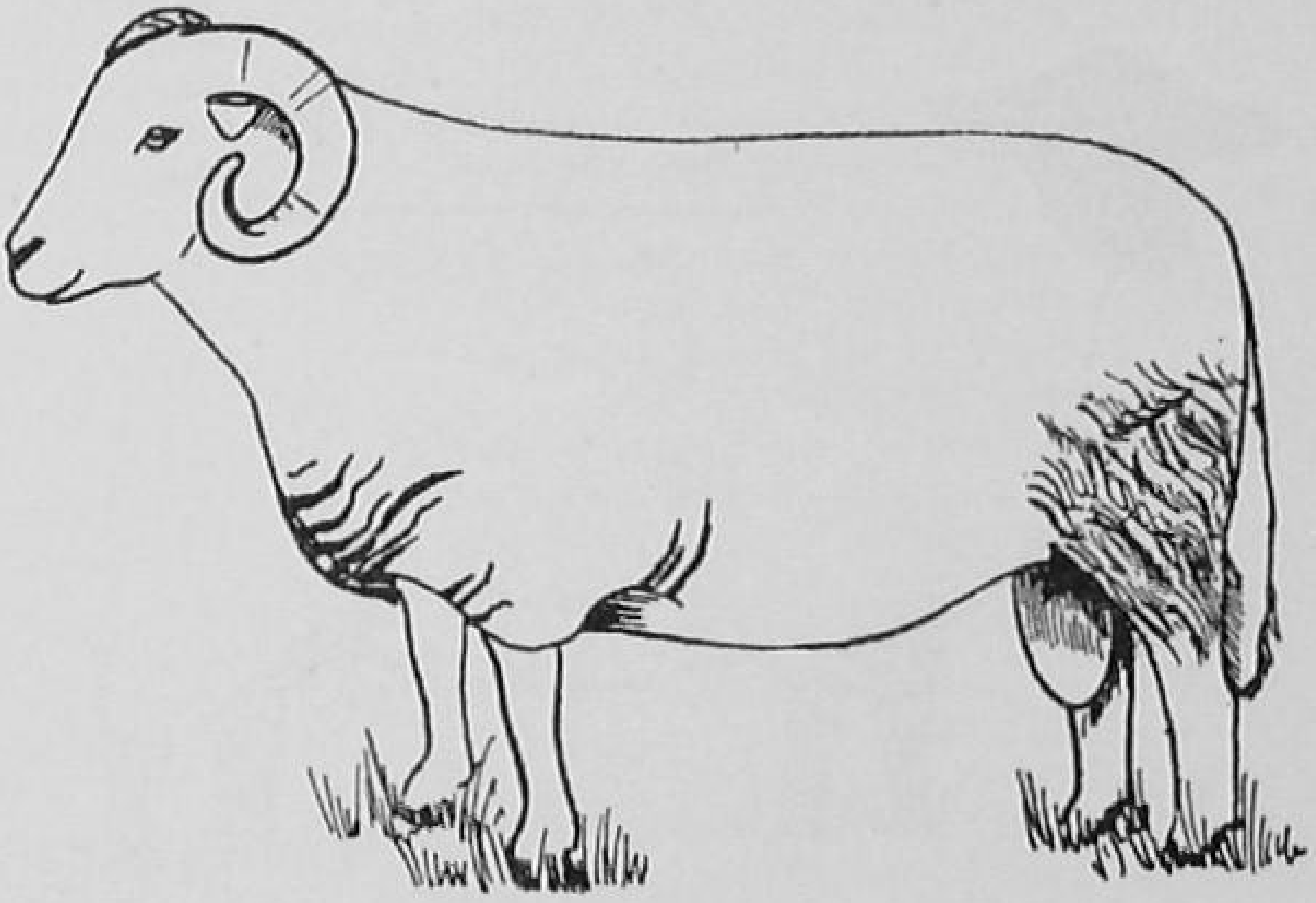
The Merino

No account of breeds of sheep could be satisfactorily concluded without some details of the Merino breed. It is not a British breed, though small flocks have been tried from time to time, but its economic importance in other parts of the world is so great that its name has become almost a household word and is certainly better known than the names of our own breeds of sheep. The early home of the Merino was Spain, whence it was exported to Southern Europe and to Germany. Numerically, it did not achieve real importance until the huge Merino flocks of Australia and to a lesser extent those of South Africa and New Zealand were built up. In the dry parts of these countries, where only sparse herbage is produced, the wool is of very fine quality; in contrast, the mutton produced under such conditions by pure-bred Merinos is very poor quality and where both wool and mutton are required the breed is crossed with longwool or down breeds of British origin producing the Corriedale in New Zealand (Lincoln × Merino) and the Polworth in Australia (Leicester × Merino).

The Merino sheep has horns, a heavy head with a Roman nose. The head and the whole body is covered with wool and the wool-bearing surface is increased by the presence of folds in the skin; this characteristic is being intentionally bred out in some types of Merino, notable the Rambouillet in Canada. The density of the wool is very great and 45,000 wool fibres frequently originate in a square inch of skin surface; the outside of the fleece should be very close to prevent the entry of dust into the interior of the fleece. When the fleece is opened it is usually clean and pale yellow in colour due to the high proportion of grease present in the wool.

Karakul.

This is a fat-tailed type of sheep. The tail is used as a storehouse for fat, enabling the sheep to withstand long periods of scant food. The animals are black, with black pendulous ears. The legs and face are covered with short, fine, lustrous, black hair. The ewes are hornless and the rams horned. The wool is coarse and long and varies in colour from black to brown or light grey. The lambs have black wool at birth with a curly and lustrous coat. The breed is formed mainly in Persia, South Russia and Turkey, but has been exported to the United States and Canada. Broad-tail is produced from lambs prematurely born; Persian lamb from lambs 3–10 days old; Karakul is a lustrous fur of wavy pattern taken from lambs not more than two weeks old.



WELSH MOUNTAIN
FIG 10.

Cross Breeding.

A ram from any breed will mate with a ewe from any breed if opportunity offers. Some of

these matings are most successful and a lot of the best points of both parents appear in the progeny which are surprisingly uniform; some of these matings are much less successful and many of the poorer points of the parents are found. In deciding upon the breed of ram and on his points as an individual it should be borne in mind that he will probably influence about 60 lambs per year for four years, or 240 lambs in all. He must be pure-bred and it is probably better to select a ram from a good uniform flock rather than to take a flashy individual ram from a poorer flock. Almost every conceivable cross between the 30 British breeds has been tried and the information has already been included in the breed data earlier in this section.

It may be summarized thus:—

	Mated to:
Mountain ewes	Rams of same breed.
	Down rams for mutton production.
	Longwools of various breeds to produce breeding ewes.
Longwool ewes	Rams of same breed.
	Down rams for mutton production.
Down ewes.	Rams of the same breed.
	Occasionally (but not often) mated to a different down breed.

First cross ewes such as Border Leicester × Cheviot, Wensleydale × Scotch Blackface, Border Leicester × Scotch Blackface, Border Leicester × Welsh, Southdown × Kent are satisfactory for breeding purposes but breeding should not be taken to the next generation, *i.e.* having mated a Suffolk ram to a Border Leicester × Cheviot ewe, the ewe lambs from this cross should not be retained except in exceptional circumstances. There have been exceptional circumstances recently; the winter of 1946–47 caused appalling losses among breeding ewes and farmers at such a time have an excuse for keeping on almost any ewe of whatever cross to tide them over the period of shortage of breeding ewes.

THE SHEEP YEAR

A description of the autumn sorting of ewes, the selection of rams, flushing, mating, wintering, lambing, the rearing of lambs, washing, shearing, dipping and weaning.

Autumn Sorting of Ewes.

A FLOCK of ewes which has just produced and reared a crop of lambs is bound to incur some casualties, which must be replaced if the strength of the flock is to be maintained. The experienced flockmaster and his shepherd will together decide which ewes must be removed from the flock and which should be retained for a further year to breed again. This examination of the ewes will take place about a month before mating and is one of the jobs which flockmaster and shepherd must do together; each of them has important data to contribute to the discussion of each ewe. The flockmaster will decide whether he wishes to remove a large or smaller number of ewes from the flock and whether the appearance of any particular ewe satisfies him or not. In the autumn of 1947 flockmasters were left with comparatively short supplies of breeding sheep replacements and they therefore decided that they must retain a somewhat higher percentage of their existing ewes than would normally be the case. The autumns of 1945, 1946 and 1947 saw the prices of breeding sheep very high and flockmasters were forced to retain a higher percentage of their ewes.

A ewe which is drafted out of the flock is known as a " cull " or " draft " ewe and the process of identifying these ewes which are to leave the flock is known as " culling." The shepherd plays his part in the recognition of the individual ewes and in supplying the history of their breeding performance. Tremendous variation occurs within a flock of apparently uniform ewes. Some will produce twins every year and rear both of them, some will produce twins, but only have enough milk for one lamb, some have little milk at lambing time and only start to produce enough for their lambs after an interval, during which the lambs do badly. Maternal instinct varies greatly and a ewe which tends to leave her lamb or which only accepts the lamb reluctantly is a source of trouble and should be removed if a replacement is available. Whilst the shepherd supplies information appropriate to each case, the ewe's udder, feet and teeth are examined, and as a result of all this the flockmaster makes his decision as to whether the ewe shall be culled or retained, bearing in mind the chance of replacements and their cost if they have to be purchased. A ewe must have a sound udder and be capable of producing milk again in both its halves, her feet must be sound and free from lameness and she must have a full set of eight incisor teeth. Only in exceptional circumstances when the flockmaster has few young sheep of his own and is reluctant to purchase any, should ewes with missing incisor teeth be retained. Should they be retained they must have a better level of nutrition than full-mouthed ewes. Barren ewes, which failed to produce a lamb in the last season, may be given another chance if the culling is to be light; they will frequently breed again.

The ewes are sorted into flocks of about 40, the number which will usually run with one ram; it is usual to mark them with a number indicating the number of lambings they have had. This mark will have been made at shearing time on one side of the ewe and may be repeated in autumn on the other side. The young ewes should be sorted first and amongst them there should be few rejects; as the age groups proceed the rejection will become heavier, the old ewes being heavily or lightly culled according to the supply of replacements available. The young sheep which are to provide the replacements should be selected as far as possible from twins, provided that such a policy does not affect the size of the individual sheep, as it sometimes may if carried on for too many years. Selected in this way sheep will be more likely to produce twins themsleves. When breeding sheep are scarce and the sheep population is low, as in post-war years, the question of mating ewe lambs during the year of their birth instead of the following year is always discussed. Lambs are normally born in the spring and mating therefore takes place in the autumn, so that ewe lambs must either be mated when only about eight months old or not until they are 18–20 months old. Ewe lambs which are to be mated during the year of their birth should be born early in the year and mated late; it is thus possible with lambs born in February, whose mating is deferred until November to obtain nine months growth. Only well-grown ewe lambs should be mated, the remainder being mated at 20 months old in the ordinary way. Somewhat naturally the lambing results will be on the low side; between 10 and 20 per cent of the ewe lambs will probably not produce a lamb and if as many as 80 lambs are reared from 100 ewe lambs it may be considered good. The resulting 80 lambs will probably be small and rather delicate so it would be unwise to retain them for breeding. The mothers, provided that they are well fed whilst in-lamb, should not suffer and will ultimately reach almost the same adult weight as a female which has not been bred from in her first year.

Selection of Rams.

The flockmaster will have given much thought to this subject and the decision and purchase should be made at least a month before mating is to take place. It is only possible here to lay down broad principles, and space cannot be spared to discuss the points to be observed for individual breeds. Suffice it to say that to the uninitiated

two rams may appear almost identical in appearance but may differ in price by £100 or more; the reason is perhaps one of the smaller points of the particular breed, known only to those who have studied the breed. The ram must be a good specimen of his breed, sound on his feet, with straight pasterns, a free action and be neither too fat nor too thin. His teeth must be correctly placed and he must not have either overshot or undershot jaws. Mutton breeds should be compact and low set with well-sprung ribs.

Flushing.

A ewe mated when she is in hard, thriving and improving condition is more likely to produce twins than a ewe which is too fat or in poor condition. The process of getting the ewes into "improving" condition is known as "flushing." It is advisable to let the ewes get down a little in condition after their lambs are weaned and then to achieve the improving condition by good feeding for about three weeks before the rams are turned in. Feeding of concentrated food is not essential and the result may be achieved by running the ewes on fresh, clean grass or on a new clover or sainfoin ley or on kale, rape or mustard. Stubbles undersown with trefoil and ryegrass may fulfil the same function. The purpose of flushing is to increase the number of eggs (ova) released from the ovaries of the ewe, thus rendering the ewe more likely to produce a multiple birth (twins or triplets). In addition the ewes will take the ram more quickly and therefore lambing will occur in a shorter, more concentrated period, instead of being dragged out over many weeks.

Mating.

Opinions differ as to the number of ewes which should be mated to one ram. A ram in good or improving condition can serve more than one that is in poor condition. An immature ram should not be allowed more than 40, but a mature ram may be given 50 or 60 if necessary, though 40 should not be exceeded unless there is some good reason. In a small field a ram can serve more ewes than he can if the ewes have a large "stray." A ram can serve far more ewes than this if they are brought to him, so that his energies are conserved, but this necessitates much extra labour and the use of a "teaser" ram to find those ewes which are "on heat." The teaser ram has a sacking apron put round him so that he is unable actually to serve the ewes. Alternatively he may be vasectomized.

Ewes normally come "on heat" (œstrum) during part or the whole of the period August to February. Individual ewes and the different breeds differ in their habits, the most notable being the Dorset Horn, which only misses about two months in the year (about May or June). The period during which mating can take place is therefore limited and naturally, therefore, the lambing season is correspondingly limited. Oestrum occurs every 17 days, but may differ with the individual from 14–21 days, and its duration, also subject to variation, is 36 hours. It is customary to paint the ram between his forelegs with red paint before he is turned into the field with the ewes. The paint may be manufactured on the farm by mixing linseed oil and a red powder (oxide of iron) bought for sheep marking and known as "keel" or "raddle." The linseed oil keeps the paint moist, but at the start of the mating season when the ram is serving a number of ewes the paint should be renewed daily. Later in the season once a week is adequate. As the ram serves a ewe he marks the ewe's rump with paint from his chest. It is commonly observed that 10 or 12 ewes may be served in the first twenty-four hours that the ram is with them. This indicates that ewes may be served at any time during their thirty-six hours œstrum. At the end of 17 days all the ewes should have been on heat and should have been served. The colour is now changed to blue. If all the ewes are now marked with blue over the red paint, the ram has obviously failed to get the ewes in lamb and should be changed. If only a few are marked with blue this may be looked upon as normal. Not only is the changing of the paint an indication of the efficiency of the ram, but it also makes possible the sorting of the ewes into early lambers and late lambers if required. If painting is not employed the rams must be changed round at the end of 17 days; otherwise one "dud" ram may never be discovered and may leave a legacy of 40 barren ewes. If the rams are changed round, his successor will serve them when they come on heat again. An observant shepherd always has a good idea of how the rams are working.

It is not yet practicable to mate ewes between the months of February and August (except Dorset Horns). It appears that by means of injections ovulation (the shedding of eggs from the ovary) can be induced, but since œstrum may not occur in association with ovulation (*i.e.* soon after injection) the ram would not serve the ewe. Since the inducement of œstrum-plus-ovulation is only in the experimental stage it is not practicable to do it on the farm. Artificial insemination, carried out during ovulation but without œstrum would be satisfactory, but is not really practicable on a commercial scale owing to the number of animals involved. It is of interest to remember that before the Second World War lambs were born in Poland and the Argentine sired by a ram which had not left England. Considerable difficulty would be experienced in feeding and rearing lambs born between July and January; they would be born then if the February to August matings under discussion were successful.

Autumn Dippings.

This is the next consideration and may be carried out before or after mating, even up to six

weeks before lambing if care is used. The object is to clear the ewes' fleeces of keds (see page 617) before they are heavy in lamb; for when heavy they may get stuck on their backs whilst trying to relieve the irritation by rolling on their back; stuck in this position they will quickly be suffocated. The type of dip used and the method of dipping are described later in this section.

Lambing.

The successful or unsuccessful results of the lambing season are often referred to as good or bad luck. There is of course some " luck " in lambing; dogs may worry the ewes, the weather may be very bad as it was in February and early March 1947, foxes may attack the lambs and so on, but the great majority of the factors leading to a successful or unsuccessful lambing season are under the control of the flockmaster and his shepherd. The selection of ewes and rams, the flushing of the ewes, mating and dipping have been discussed and winter feeding will be discussed under the the heading "THE FEEDING OF SHEEP " pp. 621–623. These are the most important items of management, and properly carried out they should result in the ewes approaching lambing time in good condition.

The gestation period is 147 days, subject to a little variation on either side of that number. It is customary to bring the ewe flock as near to the homestead as possible as lambing approaches, so that the shepherd's work in watching and feeding the flock is rendered less difficult. In arable flocks this is not possible because the flocks lamb on the field on which their food is growning and the shepherd consequently lives temporarily in a wooden hut on wheels close to his flock. The use, year after year, of the same field for lambing should be avoided, owing to the possibility of disease being carried over from one year to the next. Worse still is the old-fashioned permanent lambing yard, which was either especially built for the purpose or constructed on the same ground in a corner of the stackyard or some other convenient place near the homestead. These pens were almost impossible to disinfect and are now rarely found. Arable flocks are usually provided with a temporary, but well made, lambing yard of thatched hurdles or of two lengths of wire-netting stuffed with straw; this is necessary chiefly to provide a dry, warm place for the ewes to lie, instead of leaving them in a muddy fold. It is also better for the new-born lamb to have a dry, warm bed. Grass flocks are not usually provided with any elaborate pens, but receive some protection from thatched hurdles driven into the ground. Behind these hurdles lambs can find shelter from the wind and the shepherd can carry weak lambs into this shelter if he thinks fit. A ewe will follow her lamb when it is being carried; she does this more easily if she can see the lamb all the time. The shepherd should also be provided with a few spare hurdles in each field and a small pen of thatched hurdles, in which he can fasten either a ewe which is not taking to her lamb or one that is being used as a foster mother.

If possible, the tegs which are lambing for the first time should be run separately from the older ewes and be as close to the shepherd's eye as possible. They are more trouble at lambing time and need more individual care and attention.

A ewe which is about to lamb usually separates herself from the flock and shows signs of restless-

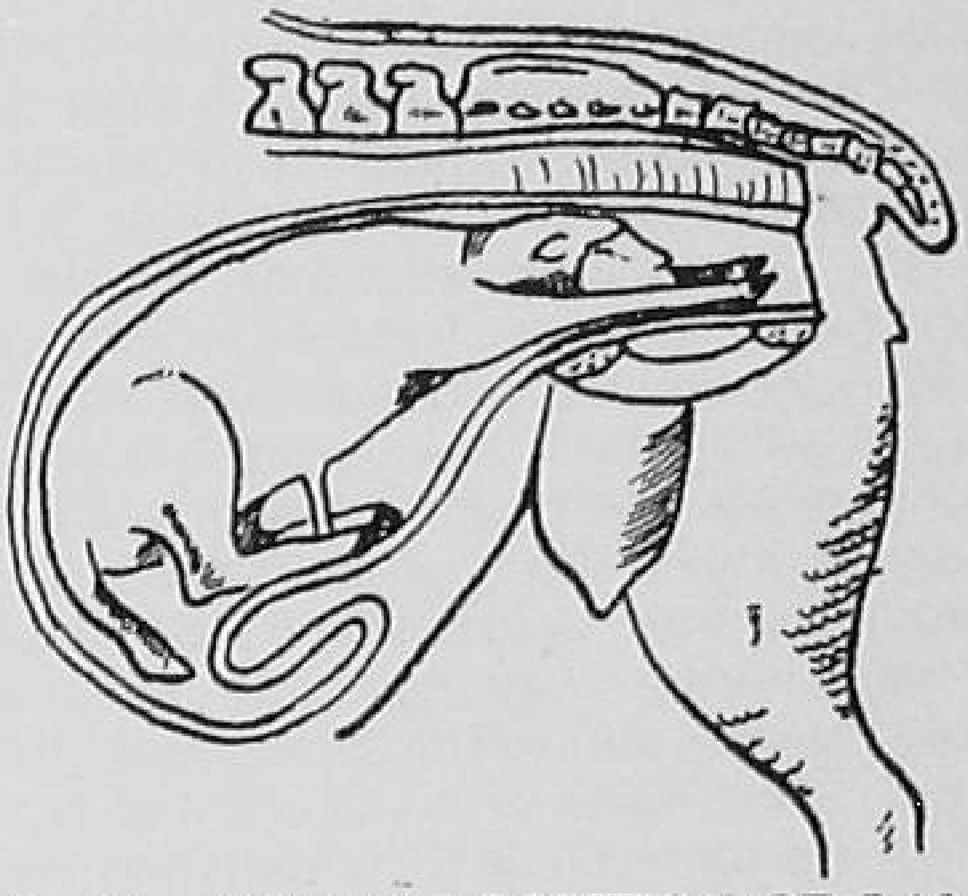


FIG. 11. NORMAL POSITION OF LAMB BEFORE BIRTH.

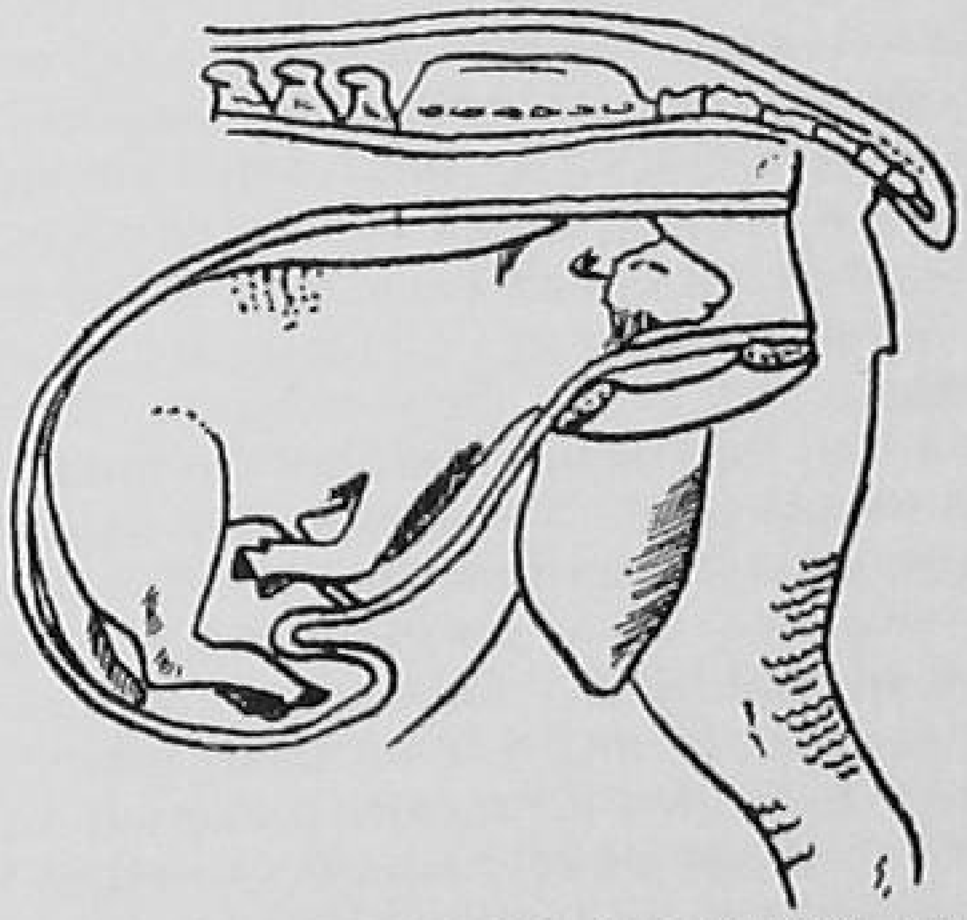


FIG. 12. ABNORMAL POSITION OF LAMB BEFORE BIRTH WITH FRONT LEGS DOWN. THE FRONT LEGS MUST BE RAISED BEFORE BIRTH CAN TAKE PLACE

ness; she will scrape the ground with her forefeet, bleat, lie down and stand up alternatively and at intervals will settle down to graze. Once the lambing pains have started she will strain whilst lying on the ground on her side, her head usually being raised as each strain is taken. The shepherd will notice the time at which ewes start to strain; if on his next visit, which may be perhaps two hours later, the lamb has not been born he will suspect that the ewe needs help. On farms where all the lambing ewes are together in one field the supervision of progress is easier than on

farms where the shepherd is making a constant circular tour of a number of separate flocks of 40 ewes.

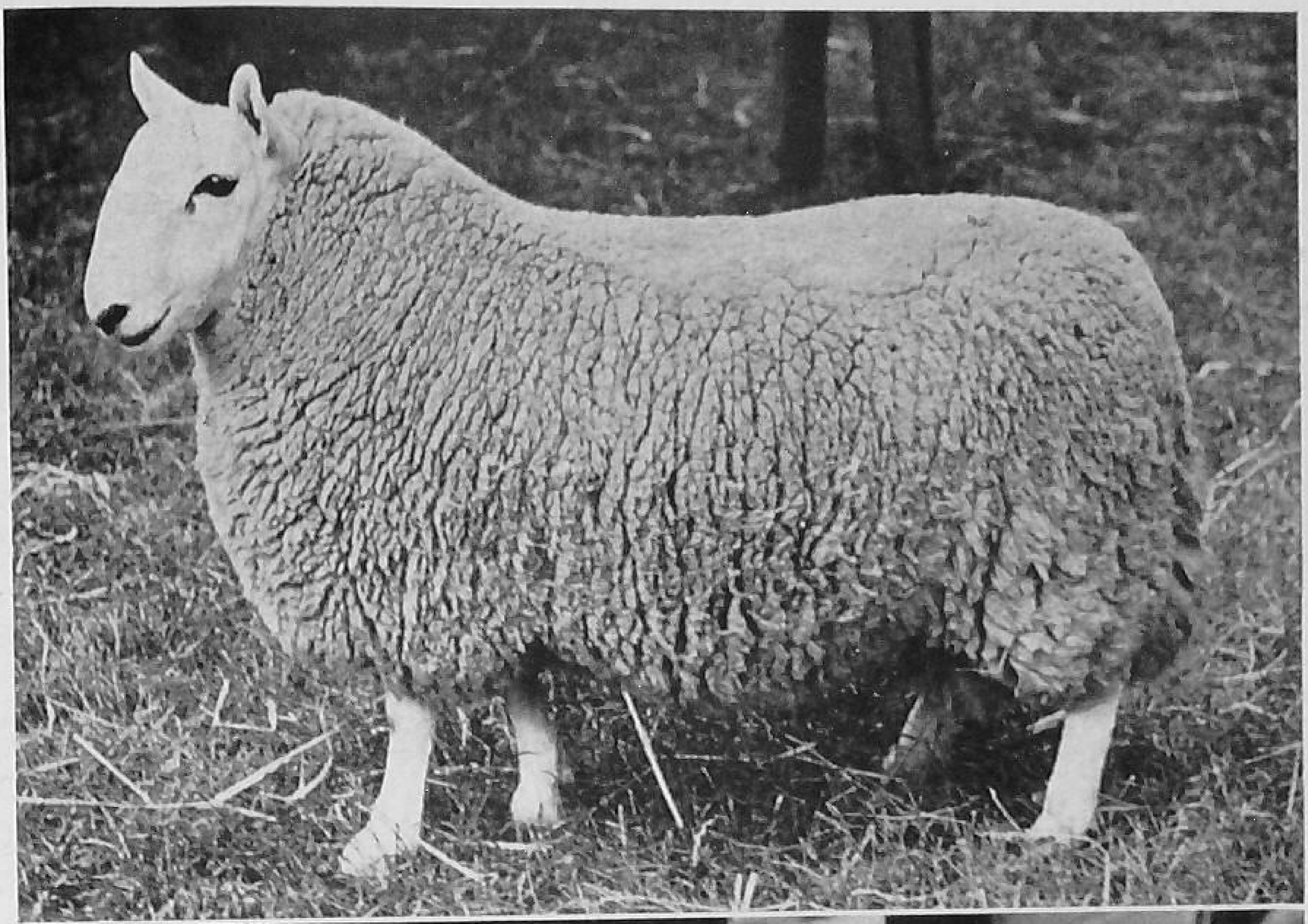
The act of birth is normally carried out by the ewe without assistance, the lamb being born in the position of someone diving, the head being laid between the outstretched forelegs (see Fig. 11). The most difficult parts of the lamb to which to give birth are the head (the legs being in the passage at the same time) and the shoulders. The lamb may be born with its mother standing or lying down; the navel cord is broken by the fall of the lamb or by the ewe getting up from the ground. The birth described above is known as a normal presentation. Abnormal presentations occur, however, and usually necessitate human aid. The commonest abnormal presentation occurs when one of the forelegs is left behind and only one foreleg and the head enter the passage. This spoils the streamlined effect of the normal position and birth is almost impossible; the remedy is gently to push back the head and leg into the womb, collect the missing leg and guide them into the passage into the correct position. Worse still is the presentation of the head only, both forelegs being left behind; the remedy is the same, the head being gently pushed back and the two legs collected into the correct position. The head may be tucked down between the legs or bent round to one side, in which case it must be got into the correct position before the birth can proceed. The position known as a breed presentation (the hind legs and rump leading) can be dealt with by the ewe without help provided the hind legs are extended and come into the passage first; if the hindlegs are doubled underneath the lamb they must be brought forward into the passage first, but the lamb need not be turned round. Numerous complications can arise where more than one lamb is present in the womb. It is always necessary, when making an examination, to be certain the legs and head presented belong to one lamb; injury may obviously be caused if pressure is exerted on the legs of two lambs under the impression that they both belong to one. Any pressure exerted should always be in a downward direction, that is to say towards the ewe's hocks. Prior to making any examination of the ewe, the hands should be clean and smeared with carbolized vaseline, this being both a disinfectant and a lubricant. Many cases may be examined with dirty hands without damage, but sooner or later a valuable ewe will be lost through infection; the precaution is therefore necessary.

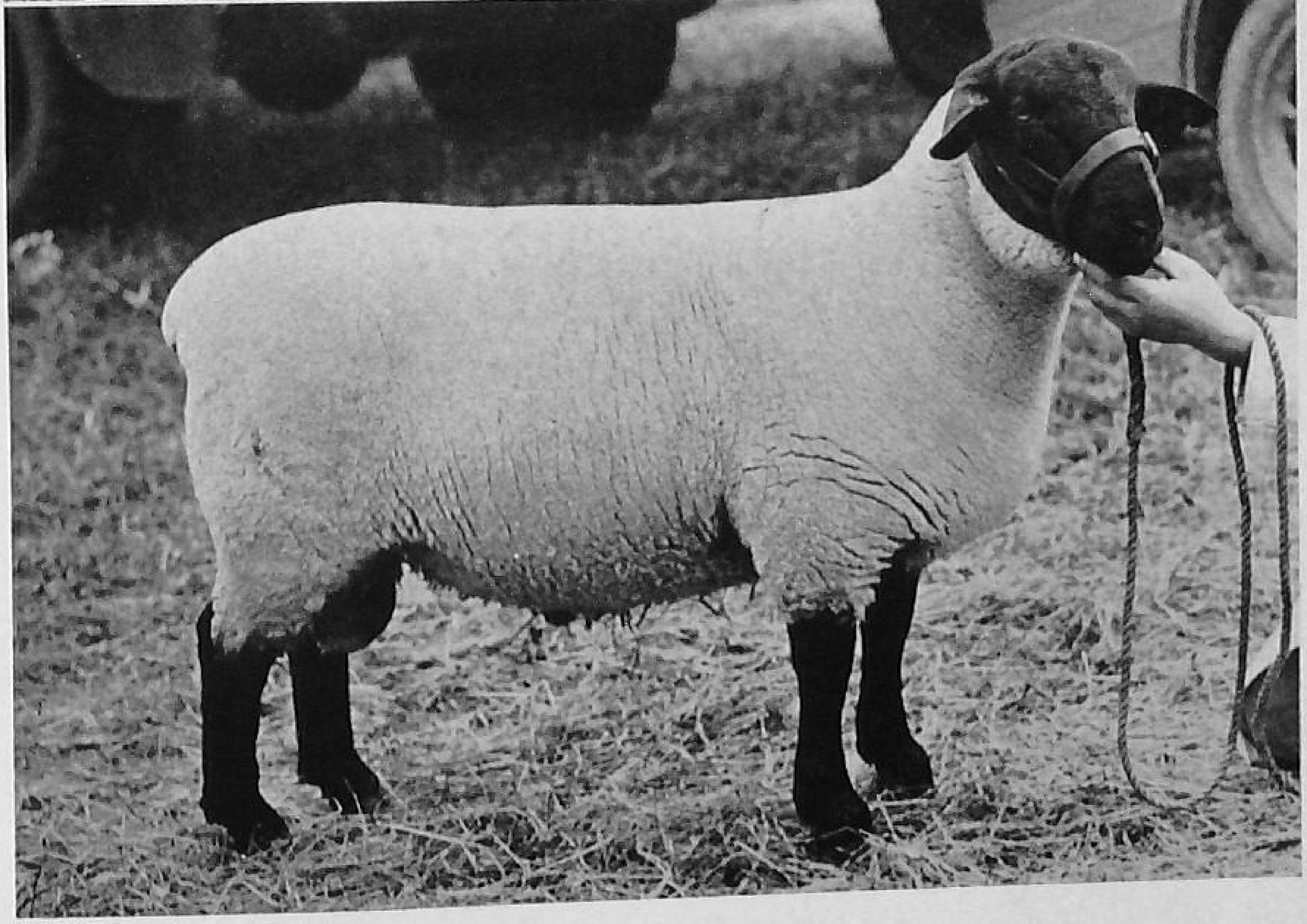
Care of Lambs.

The lamb is born wet into what in Britain in February or March may well be a cold, wet world; so every assistance must be given to it to enable it to get a good start. The ewe may be a great help in warming the lamb by licking it and standing still so that the lamb has every chance of finding the right place from which to obtain milk. She may on the other hand leave the lamb altogether, especially when it is her first lambing.

The shepherd should disinfect the navel cord with iodised phenol or some other disinfectant preparation; the cord is raw and an easy point of entry for infection, so that disinfection is required and rapid drying up of the cord must be encouraged. It is common practice to mark both twin lambs with the same number so that if one gets lost it can be identified and put back with its mother. The lamb should obtain milk, from its mother, within a short time of birth and the shepherd must ensure that it does so; nothing warms a lamb and gets it out of danger better than its mother's milk. Much juggling with the lambs may be necessary if the maximum number of lambs is to be reared, for example some ewes with a single lamb have plenty of milk for two, whereas many mothers of twins have only enough milk for one. A ewe which loses her lamb should be made to rear one from a pair of twins. Much skill and patience is required on the part of the shepherd in carrying this out. The ewe with plenty of milk and a single lamb is comparatively simple to deal with. The shepherd collects a lamb from a weak pair of twins, runs it with some of the fluid which accompanied the birth of the single lamb and the chances are that the ewe will accept it as hers. If she fails to do so the ewe with her own lamb and her foster lamb should be shut up together in a small pen. If she is very troublesome she may be put in the " stocks," that is to say with her head between the ends of two hurdles which are set up as a V. The top ends of the hurdles are fastened together sufficiently tightly to prevent the ewe from getting away. If she then tries to lie down to prevent the lamb suckling, a pole running across from one hurdle to the other underneath the ewe will prevent her from doing so. When a ewe produces twins and loses one she will usually be allowed to rear the one lamb as though it had been a single, but where a ewe loses her only lamb or loses both her lambs she must be made to rear one of another pair of twins. This is not so easy because she resents the attention of any lamb which is not her own. The usual remedy is to skin one of her dead lambs and put the skin on to the foster lamb, the ewe being deceived by the smell, upon which she relies, into believing that the lamb is hers.

The shepherd must always bear in mind the backward, hungry lambs for which he intends to find a foster mother when opportunity offers. A hungry lamb, which is not getting enough milk, will follow its mother about and have an arched back and a generally miserable appearance. The shepherd's duties are long and arduous at lambing time; his last duty at night must always be to ensure that all the lambs are well fed to last them till morning; any tiresome ewes must be thrown to ensure that the lamb has a final feed before the night.



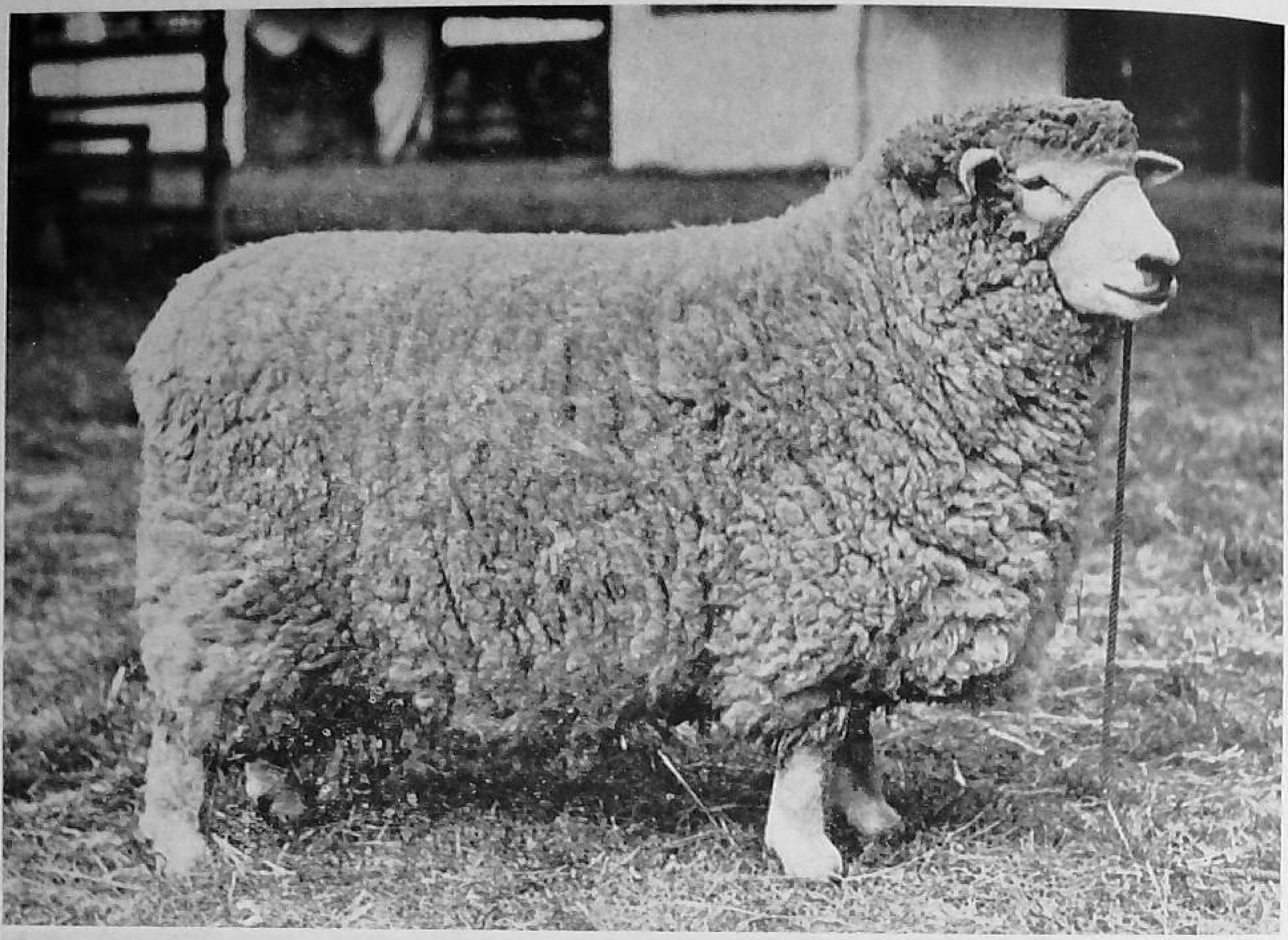


BRITISH BREEDS OF SHEEP

Above : CHEVIOT

Below : SUFFOLK RAM LAMB

Farmer & Stockbreeder Photographs



MODERN SHEEP FARMING

Above : KENT OR ROMNEY MARSH PEDIGREE PRIZE-WINNER

Farmer & Stockbreeder Photograph

Below : FLOCK EWES (ROMNEY MARSH BREED) NACKINGTON FARMS

Courtesy: Nackington Farms

The ewe's milk alone suffices for the first fortnight of a lamb's life, but from then on it begins to eat a little of the most succulent parts of grass, leaves of kale or whatever crop is available. The lambs obtain milk from the ewes until weaning, but in decreasing amounts. The lambs should have the pick of any crop on which the ewes and lambs are folded and creeps should be arranged so that the lambs can go on to the crop ahead of the ewes. Creeps consist of gaps in hurdles sufficiently large to admit the passage of the lambs, but not the ewes. The sides of the gaps must be smooth so that the lambs' fleece does not catch on them; this can be achieved either by driving a smooth round stake into the ground on either side of the gap or by using a proper lamb creep each side of which consists of a revolving wooden roller. These creeps can also be used as surrounds for troughs in which concentrated food is fed to the lambs without the ewes having access to it.

Single lambs weigh 8–10 lb. at birth and may reach a maximum of about 17 lb. Twin lambs weigh 7–9 lb. and triplets 5–7 lb. The author has weighed triplets of 11 lb., 11 lb. and 9 lb., and quintiplets of 7, 6½, 6½, 6½, and 5 lb. Each of the mothers, which were Border Leicester × Cheviots on the Wye College farm produced about ¼ of their own weight in lambs, the equivalent of a baby weighing over two stone or a calf weighing three cwt! It is perhaps interesting to record that the first two of the quintuplets were born dead, so the shepherd went off conscientiously to find a suitable foster lamb to put with the ewe. He had to go to the next field and by the time he returned the ewe had produced a live pair. The shepherd returned the borrowed lamb, went back to the ewe and found her with three, all of which lived. History does not relate whether the shepherd or the old ewe was the more surprised.

Lambs flourish best in dry, warm weather and they can stand cold far better than damp. Continuous wet weather is the worst for them. Their rate of progress depends largely on the milking capacity of the ewe; an average yield of ewe's milk is 3 gallons per week containing 7 per cent fat and 6½ per cent protein. Constant supervision by the shepherd is necessary throughout the spring and summer and a good shepherd will quickly notice signs of ill-health in his flock, such as dull faces, drooping ears, staring coats, arched backs and any tendency on the part of an individual sheep to isolate itself from the flock. He is constantly on the look-out for foot troubles and for attacks of fly, both of which are fully described under "SHEEP DISEASES AND AILMENTS. pp. 615–620.

Lambs of both sexes (in all except mountain breeds) have their tails cut short at 3–5 weeks old. Two visits are paid to each field as a rule, the majority of the lambs are tailed on the first visit (say 5 weeks after the start of lambing) and the later lambs are tailed on the second occasion. Two men are necessary to carry this out; one holds the lamb against his chest with its tail towards the operator if a knife is to be used, whilst the other man cuts off the tail. If a hot iron is to be used the tail is placed over a stone or wood block and the hot iron is pressed down onto it, searing it through. Of the two methods the latter is the more satisfactory because the hot iron sears the ends of the blood vessels and scabs them up, whereas quite a lot of bleeding may take place when a knife is used. In either case it is an unpleasant operation, but necessary in order that the lambs hindquarters may remain clean and so be less liable to attack by fly (see under "SHEEP DISEASES AND AILMENTS" in the present section, pp. 615–620). At the same time as the tailing, the castration of the male lambs not wanted for breeding is carried out. For this operation the lamb is held against the chest of one man whilst the other uses either a bloodless castrator or a knife. It has been found that lambs castrated by an expert with the bloodless castrator gain slightly more weight than those castrated with a knife, but if this instrument is used by an inexperienced operator who may apply the wrong pressure there will be a number of rigs (lambs in which one testicle still functions). When using the knife the tip of the scrotum is first cut off, the testicles squeezed down until they are visible and then pulled out with the toothed pincers attached to the knife. The knife causes some bleeding but only rarely is a lamb lost either from tailing or castration.

Washing.

The washing of sheep before shearing was once an almost universal practice. The sheep were taken either to a stream or to a specially built washing tank where they were washed in plain, cold water. The process removed most of the soil from the fleece and, rather surprisingly, also removed a lot of the grease. It was customary to wait for about a week before shearing to enable the grease to rise a little in the wool so as to make shearing easier, but not to wait so long that the wool became sufficiently dirty and greasy to be classed as greasy or unwashed wool. The washing of the sheep took quite a lot of labour, about 4 men being required for a day to wash 400 sheep; in addition to this expense there was the possibility of the death from shock of an occasional sheep, especially when the sheep were hot after being driven some distance on a hot day. Washed wool before the 1939–45 war made about 2d. per lb. more than greasy wool, but the washed fleeces were from 12–20 per cent lighter due to the washing out of grease and dirt. It was a difficult decision for the farmer to make—should he wash his sheep or not? The author in a trial with Kent sheep (N. L. Tinley, 1930) found that a producer of 1,000 lb. of greasy ewe wool annually would receive £1 14*s.* 0*d.* more per year if he washed

his sheep than if he did not. From this not very substantial sum had to be deducted the cost of wages and a share of any possible losses of sheep, so that there could only be a very small gain, if any at all. These figures were calculated after finding the weight of about a quarter of a million washed and greasy Kent ewe fleeces from the records of the Kent Woolgrowers, Ltd. The answer to the same question was supplied in the Midlands about the same time by the Central Woolgrowers, Ltd., in a circular sent to their members. They found that the unwashed fleeces made more than the washed fleeces. It can be definitely stated that even where labour is available it does not pay to wash Kent or Lincoln sheep before shearing unless the difference in price between washed and greasy wool is substantially more than 2d. per lb. in favour of the washed wool.

Shearing.

Until the weather becomes really warm in this country the sheep are better in their wool than out of it. Milking ewes can easily get a chill in their udders if shorn when the weather is too cold. The majority of sheep therefore are shorn in June, but some may be shorn during good spells of weather towards the end of May. The fleeces must be dry when shorn because damp wool rolled up in store deteriorates. In some districts the lambs are shorn as well as the ewes, the object being not so much to get the wool (about 1 lb.) which barely pays for the labour involved, but to increase the comfort of the lambs during the hot weather and lessen the chances of them being attacked by fly. The other factor to be considered in making the decision is the appearance of the lambs when they are sold. Unshorn lambs look larger than shorn lambs, but their wool looks more untidy, the tips of the staples of the first wool grown being pointed. Shorn lambs look smaller but neater since the end of the new growth of wool staples is flat and the fleece looks tighter. On the other hand, purchasers tend to say to themselves " these lambs are unshorn and the wool must be allowed for "; they therefore may pay less than they are worth, because they think so much of the apparent bulk is wool. Lambs are commonly shorn in Kent and other parts of Southern England and the decision is largely a matter of personal preference on the part of the owner.

Sheep shearing is carried out in Australia, New Zealand and other large wool-producing countries in long sheds by gangs using power-driven shearing machines, the individual knives being driven from an overhead shaft turned by an engine. The fleeces are skirted, and in some cases classed before being baled. In this country shearing is still very commonly carried out with hand shears and sometimes with a small engine driving two or three units. The work is done in the open air and should be carried out on a stack sheet to prevent grass and other impurities getting into the fleece. The actual method of shearing is the same whether hand shears or machine shears are used, but varies from district to district. The Australian method described in detail is as follows:—

(1) Sheep sitting up with shoulders held between shearer's knees. Wool is removed from brisket and belly. Sheep is lowered backwards if necessary to enable shearer to reach crutch and inside of hind legs. (2) Sheep on right side with head and shoulders against shearer's legs. Outside of the left leg and hip are shorn, going well into flank and over the tail. (3) Sheep sitting up. Face and forelock shorn. Then the neck is shorn clear. (4) Sheep sitting up, left foreleg and left shoulder cleared, working well over to the back. (5) Sheep on right side, legs bunched together so as to arch the back and tighten the skin. With long sweeps the shearer works from the flank to the backbone, each sweep being the length of the side of the body from tail head to back of head. (6) Sheep half sitting up with head bent backwards to stretch skin. Right side of sheep is shorn from right ear downwards clearing right foreleg on way down until flank is reached. Then sheep is allowed to lean further back and the last of the wool is removed until the shears reach the open space made at the end of (2). The sheep is then marked and the fleece dealt with by other men.

The author first learned to shear on Lincoln ewes and the following method was employed. (1) Sheep lying on side. Belly and inside of legs shorn. (2) Sheep sitting up. Path opened from chin, down the neck to brisket until the cut joins the belly which has been cleared. (3) Sheep sitting up. Shearer clears forelock and works round from throat to backbone continuing down the sheep as far as he can reach. (4) Sheep lying down and the rest of the side cleared to the tail head (5) Sheep sitting up. Using the other hand the opposite side of the sheep is shorn from the neck clearing round to the backbone. (6) Sheep lying down to finish the side and to make sure that hind legs and tail are shorn and that fleece is not left attached at any point. There is nothing more humiliating than releasing a sheep with its fleece still attached and seeing it running off with its fleece trailing behind it. The fleece is next turned so that it lies skin-side downwards. The edges of the fleece are turned inwards and the fleece is rolled rightly from the breech towards the neck. From the neck of the fleece a band is made by pulling and twisting, and this is placed round the fleece, pulled tight and is tucked in. The part of the fleece exposed consists mainly of the shoulder wool, so that a wool grader sees the best part of the fleece, which grows on the shoulder region. The fleeces are then packed in a large canvas sheet for delivery to the wool merchant or the co-operative wool-marketing organization, which will be fully discussed under

" Labour, Capital and Returns, pp. 624–626.

Shearers vary a great deal in the number of sheep shorn in a day. Obviously fewer large sheep are shorn than small ones, rather more sheep are shorn by machine than by hand, sheep in good condition are easier to shear than ones in bad condition, more sheep are shorn when the shearer is working on piece work than when he is working on day work. There is a tendency to exaggerate, and some " fishing stories " are certainly told. There is on record, however, the astonishing figure of 410 sheep shorn in a normal working day; they were probably very small sheep, and of course there was a man to deal with the fleeces. Good gangs in New Zealand average about 240 sheep per day (about 150 lb. sheep). In England 90–100 are occasionally shorn, but the author would put the average figure at 8 sheep per hour, so that by the time the shepherd has done his shepherding and the Double Summer Time dew is off the sheeps' backs the shepherd probably only shears for 5 or 6 hours a day which makes the flock of 40 ewes a convenient day's work.

Dipping.

When the inevitable shearing cuts are healed all the sheep on the farm are dipped. They are collected from the various parts of the farm, flock by flock, and brought to the dipping place, where they should be rested for a time so as to cool them down before immersion. The local police must be given three days' notice of impending dipping, and regulations lay down whether sheep shall be dipped once or twice compulsorily during the year and between what dates the dipping shall be carried out. All sheep in the British Isles must be dipped between 15th July and 9th September and in countries where a double-dipping order is in force they must be dipped again not less than 10 and not more than 14 days later. The first dipping, which must be carried out with a dip approved by the Ministry of Agriculture, kills the mites that cause sheep scab but does not kill their eggs. In likely scab areas, therefore, the sheep are dipped a second time to kill the young mites, which hatch after about 9 days, before they in their turn lay eggs, which they are capable of doing after 14 days. The dipping also kills ticks, keds and lice, and for a short time prevents the fly from attacking sheep. This last effect, however, quickly wears off unless use is made of one of the modern D.D.T. dips, which are said to give immunity from fly for several weeks. Alternatively, the sheep may be sprayed (as a separate operation) with D.D.T., using $\frac{1}{2}$–$\frac{3}{4}$ gallon of ·5 per cent solution of D.D.T. in water for each sheep. Fruit sprayers or knapsack sprayers may be used and 75–100 sheep can be put through a suitable race in half an hour, being subjected to the spray on their backs and hindquarters as they pass through.

In order to dip 400 sheep in a day, dipping requires a minimum labour force of 3 men for work at the dip and for collecting sheep; the actual number of sheep dipped depends upon the efficiency of the layout of collecting pens, dip and draining pens. Each sheep must be thoroughly soaked in the tank and must remain in the liquid for at least a minute (by law). The liquid must be kept reasonably clean; it is obviously useless immersing the sheep in what has become virtually liquid manure.

The Shepherd's Calendar.

September. Lambs not already sold should be given the best available keep such as a run over cleared stubbles or aftermath grazing of hay land. Keep them on dry land and give them the best available food, especially if they are ewe lambs to be mated in their first year. Watch for fly attacks which may still occur. If these lambs are to go on to arable root crops get them accustomed to arable folding either by carting turnips to their grassland or by folding them on mustard or other catch crops sown after early-cleared crops such as early potatoes and canning peas. Sort the ewe flock and sell draft ewes, dividing the remainder into flocks of 40–50 and running them over good keep for a month before mating to ensure that they go to the ram in good, improving condition. Autumn dipping may be carried out this month to rid the sheep of keds before the winter. Any purchased sheep should be dipped, put through a foot rot bath and isolated for a few weeks.

October. Ewes intended to lamb in March should be mated this month. Autumn dipping can be carried out before mating. Sheep intended for an arable winter should be put on to the first arable fold. Ewes to be mated should have been flushed by now.

November. In late lambing districts ewes may still be put to the ram. Ewe lambs, if they are to be mated in their first year, should be mated during this month. Fly is now finished but foot rot should be watched for and dealt with. The most forward of fattening sheep on the fold may be sold.

December. Ewes mated in October may now need some trough food and hay must be supplied in snowy weather. Sheep on the fold will require hay and trough food if available. Watch for any lameness in sheep and deal with it.

January. Ewes and folded sheep must be fed as well as supplies permit. Early lambing flocks for the production of ram lambs will start lambing and much care and feeding will be required. In-lamb ewes must never be allowed even one hungry day and must not be overdriven or chased by dogs.

February. Lambing continues in early lambing flocks with heavy extra feeding and arable crops provided. Lambing yards are usually provided or thatched hurdles are set up to give

protection. Young sheep folded on roots are now shedding their milk teeth; if it is possible to pulp roots for them this is an advantage. Ewes due to lamb on grass in March should receive some mangels if possible and also some trough food.

MARCH. Yearling sheep off the fold should be sold as soon as possible, otherwise the crop, which is to follow the roots will suffer. The lambing season for grassland flocks begins, though there is little grass for them until April. Trough food pays good dividends and mangels are readily eaten. Some protective thatched hurdles should be put up as shelters. Trim away some of the loose wool round the ewes udder but do not overdo this or chills will result. Easter fat lambs are sold if Easter comes in March, otherwise in April.

APRIL. Grass should now be coming along well. The trough feeding of the grass ewes may be gradually transferred to the lambs in creeps. The fleece being now long, some losses may occur from sheep becoming cast (stuck on their backs); constant shepherding reduces this loss to a minimum. Arable flocks may be moved on to seeds if they are forward enough. Mountain flocks lambing.

MAY. Arable flocks transfer to seeds leys. Grassland ewes and lambs are now enjoying a flush of grass on their seeds leys or permanent pasture. Stock must keep the grass down and if necessary some fields may be shut up and the stock concentrated in other fields. Fly may attack the sheep this month if weather is damp and warm. Shearing is general. The latest lambing in mountain flocks is completed. The hindquarters of ewes and lambs should be trimmed so that the hindquarters do not become soiled if the sheep scour as a result of the grass flush.

JUNE. Shearing is completed. Fly attacks should be less likely now that the wool is off. Trough feeding of lambs may be continued in normal times, when food is plentiful.

JULY. Dipping takes place. Lambs for sale as stores are frequently sold this month, being weaned on the day of sale. Run the ewes on poor pasture to dry up the milk. Dorset Horn flocks for Easter lambs are mated.

AUGUST. Many sheep sales take place this month—ewes, tegs, rams, store lambs and fat lambs. Dipping continues. Flocks which are to lamb in January and February for ram production, should be sorted and mated. Fly is still troublesome.

SYSTEMS OF SHEEP FARMING

A description of Mountain and Hill sheep farms, Grass sheep farms and Arable sheep farms. The place of the sheep on mixed and dairy farms is explained. The use of Easter lamb flocks and flying flocks and the production of sheep for exhibition is here described.

Mountain and Hill Sheep Farms.

MOUNTAIN breeds of sheep are quite commonly found on lowland grass farms, but lowland breeds are never found on the real mountain and hill farms. On mountain and hill farms will be found one or other of the mountain breeds which have already been described in this section, pp. 578–590. One or two hardy non-mountain breeds such as the Kerry Hill and Masham may be found on the lower parts of these farms. The areas concerned are 1,000 feet above sea level or more and are found in Scotland, Wales, the Lake district, Pennines, the Yorkshire Moors, the Peak district, Dartmoor and Exmoor. The herbage includes heather, rushes, fine-leaved fescues and bents and only sheep of very hardy types would derive a living from it. On the highest areas there are often no boundary walls and the sheep have the free range of many hundreds of acres; they remain, however, usually on the same part of the mountain or moor chiefly on account of their geographical knowledge of the area and their knowledge of the best places to shelter in storms. For this reason anyone taking over a mountain, moor or fell farm almost invariably buys the sheep that are already on that farm. Shepherding on any farm is of prime importance, but nowhere is it more vital than under such conditions as these and nowhere does it require a tougher, more conscientious or more sterling character. Hardy though the ewes are, they cannot find a living on this type of grazing once their teeth begin to fail and, since there is a good trade for draft mountain ewes to be transferred to the lowlands, they are frequently sold after they have had 3 crops of lambs and they are never retained on the high land after 4 crops. The ewes which go to lowland farms are frequently used as flying flocks, on a system which is explained later in this section. Because of the very severe conditions, the young ewes are often not mated until they are 2½ years old, a year later than normal; this enables them to gain size and strength before the strain of carrying a lamb through the winter. Lambing time is normally not until May though a few may lamb in April; shearing is usually deferred until June. The hill flockmaster considers himself very lucky if 100 ewes put to the ram rear 100 lambs. Firstly, the grazing on which they have to live is very poor, secondly, the ram may fail to find and serve some of the ewes, thirdly, the losses amongst ewes are higher during the winter than they are in the lowlands and, lastly, losses amongst the lambs, hardy though they are, tend to be higher on the hills. Lamb figures of 80–90 lambs per 100 ewes mated are quite common. During their first winter, lambs which are to be retained are wintered on lowland or in the enclosed grass fields near the homestead. Nearly all the ewe lambs have to be retained in order to replace wastage amongst the ewe flock. Most mountain and hill farms have some enclosed grass fields that can be used for this purpose and some arable land. Many moorland and hill farms used to run cattle as well as sheep and it is noticeable that where cattle-keeping has been discontinued the grazing has deteriorated; the same may be said where the keeping of 2- and 3-year-old wether sheep has been given up in these areas. These sheep are fully grown and consequently take less out of the land than pregnant or milking ewes or growing lambs and they also remove by their method of eating, the rougher, badly grazed tufts of herbage, and this enables the finer species to survive. One of the reasons for giving up cattle keeping is that these animals require a certain amount of winter feeding, which was difficult and laborious, whereas the mountain ewe receives no extra food except during periods of snow. In recent years on some moors (notably Yorkshire) bracken has spread and has pushed back the useful heather, on to higher ground; this must tend to reduce in some measure the sheep carrying capacity of the moor. Serious moor fires such as occurred during the summer of 1947 have a like effect.

Much work has been carried out on the ploughing and reseeding of hill pastures, especially in Wales under Sir George Stapledon. It is quite possible, in suitably selected cases, to plough up heather land, fence it, lime it, sow it down with a mixture including lowland grasses; so that an incomparably more valuable area of sheep grazing is established. The disadvantage of this procedure is that while much summer grazing is gained at considerable cost, the winter position, which is the more difficult, is unaltered. In the future some means of raising the winter stock-carrying capacity of these areas may be devised; it is little good preserving the summer surplus grass as hay, silage or dried grass for the winter because its cost and the impracticability of feeding it daily to the sheep on inaccessible mountains, moors and fells prevent it being much use.

The Minister of Agriculture, in a statement in June 1947, estimated the losses of sheep and lambs in the winter of 1946–47 to be four million, of which three million were amongst hill sheep. During the period of very severe weather in January, February and March 1947 very heavy losses occurred amongst in-lamb ewes; in some Scotch Blackface flocks this reached 50 per cent and of the surviving ewes many subsequently died or produced dead or weakly lambs. From

such a blow the sheep population requires some years to recover, even if every ewe lamb is retained for breeding.

Upland Grass Sheep Farming.

This type of farming was a characteristic feature of the years between 1918 and 1939 on light upland soils such as are commonly found on the chalk formation. Large areas of such land are found in Berkshire, Wiltshire, Dorset and Hampshire, and there are smaller areas in Sussex, Kent, Lincolnshire and Yorkshire. Before and during the First World War this land was mainly under the plough and was farmed on a rigid 4-course rotation of Roots, Barley, Seeds, Wheat, one quarter of it (the seeds) being used for grazing. The sheep were wintered on the roots and summered on the seeds and upon the little permanent pasture that was to be found on these farms. The sheep were largely responsible for maintaining the level of fertility and prices for corn and sheep were such that the rotation was economically sound. After War I, the prices of corn and sheep fell rapidly, but wages remained far above the pre-war level. Farmers found that it was impossible to maintain such land under the plough, with corn at such a low price and when the root crops for the sheep were so expensive to grow. Sugar-beet was grown on some of this land, but grass became a more and more noticeable feature of the area. In many instances this grassland was unsuitable for open-air dairying because of the difficulty of water supplies; in consequence it was grazed by sheep, of which many new breeds and types made their appearance. The Border Leicester × Cheviot, the Kerry Hill, the Masham, the Greyface, the Welsh Mountain and many others were used, chiefly because they were more economical to feed than the arable down breeds previously employed, and also because they were usually more prolific. Unfortunately, owing to the economic depression through which farming passed between the wars, much of this grass remained too long unploughed and practically no fertilizers were applied, so that the sheep did not do so well as they should have done and the crops which were grown when the grassland was finally ploughed up were disappointing. This land is often spoken of as marginal land, because it only becomes profitable to plough when prices are high and is quite unprofitable under the plough when prices are low. During War II it came under the plough again and the loss of grass consequent upon breaking it up was responsible for a part of the decline in sheep population. The system of managing the sheep was in accordance with the routine management of a flock of sheep described under "THE SHEEP YEAR," pp. 591–598 in the present section. Flying flocks were often employed.

Lowland-grass Sheep Farming.

It is perhaps partly the author's local prejudice which includes a special section of sheep farming under this heading, for its chief area is the Romney Marsh district in Kent. Lowland grass as a rule is employed for cattle grazing, but until the Second World War Romney Marsh carried a greater density of sheep than any other similar area of the British Isles; at the same time it was almost devoid of cattle. The breed of sheep kept is predominantly the Kent or Romney Marsh, the general management of which follows the course already described under the heading of "THE SHEEP YEAR." The lambs are wintered on the uplands of Kent, Surrey and Sussex, and return to the Marsh in the following spring, being fattened as yearlings or wintered in the Marsh for their second winter and fattened as two-year-olds; occasionally three-year-old wethers are still found in the Marsh. The quality of the grazing varies enormously, much of it being used as breeding grounds only, but a considerable area is magnificent fattening land, one field in particular carrying and fattening as many as fifteen sheep per acre in the height of a good grazing season. Fields of this quality are grazed only by fattening sheep and the grass is never allowed to grow to any length, the sheep population being adjusted from other fields according to the rate of growth. These fields are used as concentrated food for the final weeks of fattening.

Arable Sheep Farms.

Until recent years, from the introduction of the turnip and swede crop in the 18th century, some breeds of sheep were supported mainly on arable crops; but recently many contributing factors (labour cost in particular) have led to a decline in the practice. Formerly, turnips, swedes, kale, rape, mustard and certain forage crops and seeds mixtures were grown so as to provide a succession of crops on which the sheep were folded. Folds were made of wire netting, netting, wooden hurdles, iron hurdles or wattle hurdles, a suitable part of the crop being enclosed to last the sheep for one or two days. Naturally, the land on which this system was carried out had to be reasonably dry and well drained; even on such land, the folds (and the sheep) got extremely dirty during wet weather. The areas in which this system was practised (and still is, to a much lesser extent) are much the same as those described in the section on upland grass sheep farming. It is simpler to enumerate them again, mentioning other areas in addition where arable sheep are found. There is much suitable land in Hampshire, Wiltshire, Berkshire, Dorset, Kent, Cambridgeshire and Sussex on the chalk uplands and further north on the Lincolnshire and Yorkshire wolds; East Anglia makes a big contribution on the light soils of Norfolk and Suffolk; the Cotswolds and parts of the West Midlands make some contribution further west.

The routine management of the flock is as already described under "THE SHEEP YEAR,"

pp. 591–598 in the present section. Lambing, which, in ram-breeding down flocks, may be in January or February, takes place in a lambing pen on, or adjacent to, the crop on which the sheep are folded. The lambs have creeps so that they can obtain the pick of the crop before the ewes have access to it. Rotations of crops on which the sheep are folded are many and varied; a common one is as follows:—

Mid-September—end November on rape and turnips.
End November—end January on marrow stem kale.
End January—end April on swedes or thousand headed kale.
Summer on a grass ley.

Forage crops such as sainfoin, rye, cereals plus vetches are also employed, and it is even possible to arrange a rotation of arable crops to feed the sheep for the whole year without any grass. From the above very brief description, it will be realized that the system absorbs a tremendous amount of labour both in growing the crops and also in the constant care and attention of the sheep on the fold. Its chief advantage is that it is a means of adding fertility to outlying fields to which the carting of farmyard manure would be very expensive. The description so far refers to ewe flocks on arable land, but the progeny of the ewes, if they are to be retained for mutton production as opposed to fat lamb may be retained and fattened off during their first winter on similar arable crops.

Many of the lambs bred on grassland farms are sold at store lamb sales in the late summer months and are bought by arable farmers for folding on root crops and fattening during the winter months. At the present time most arable sheep folding takes place on the farms where the 400,000 acres of British Sugar-beet are grown; it is unlikely that we shall ever see an appreciable increase in arable sheep folding again.

Sheep on Mixed and Dairy Farms.

The lambs on a mixed farm are usually sold as fat lambs or store lambs in late summer, so that the following discussion relates to the ewe flock and not to any young sheep, apart possibly, from a few young ewes to be used as flock replacements. Most mixed farms, even in the midst of a ploughing-up campaign, have a certain amount of permanent pasture, which should be grazed bare during the winter months. This is one of the functions of part of a ewe flock on a mixed or dairy farm. The cow pastures are all the better for this close grazing by sheep. However, there is comparatively little permanent pasture in these days and most of the grazing is grass leys and clover leys. The grazing of these leys forms the staple diet of the mixed farm sheep. But most farms have some crop residues which the sheep can clear up, such as sugar-beet tops, the remains of cabbage and sprout crops and some residues from the corn stubbles. However, the amount of the residues of market garden crops is frequently too small to justify the labour and expense of the fencing or folding involved, unless the grazing situation is very difficult at the time. The number of sheep per acre that should be grazed on this type of farm depends, of course, on the other stock using the same field and also on whether the sheep concerned are in the field for a short period or are making it their home perhaps for the whole year. In this country the disparity between the amount of sheep feed produced by a pasture in summer and winter is very great. Whilst for several months during the winter growth is probably virtually at a standstill, always in May and June growth is very rapid. In a moist July, August and September, too, it is also quite rapid. The stocking during the winter should not be more than 1–2 ewes per acre on average pasture but there is bound to be some variation since the unit of 40 ewes and 1 ram will be turned on to a ley field, which may be from 10–30 acres in extent. They will obtain some keep from the ley until the end of the mating season when some of the sheep may be taken out of the more heavily stocked fields and put on to the more lightly stocked fields. All the sheep will need some supplementary foods after Christmas in the form of concentrates, mangels, silage or hay. The flush of grass in May and June can be dealt with by increasing the stocking on some fields, whilst other fields are shut up for hay, silage or taking seed. The stocking on fields which are being grazed in May and June may be 4–5 ewes plus their lambs per acre. If water is laid on to these fields and grass is available cattle should be added as required to keep the grass under control. Grazing on the system just outlined means that all the grass on the farm carries sheep for most of the year, except the fields set aside for hay, silage and seed; these get 2 or 3 months rest from sheep during the summer. An alternative method is to rest half the grass fields from sheep each year; this means carrying a smaller sheep stock and depriving half the pastures of the value of the close grazing by sheep. Another method is to stock some fields very heavily and after they have been fairly hard grazed to move the sheep to other fields which have been rested. The disadvantage of this is that in this country access to individual fields is usually difficult, and this often deters farmers from adopting this policy in spite of the very small amount of extra labour involved. Generally, circumstances make the decision about the system to adopt fairly obvious, but the farmer should always bear in mind that the sheep is naturally a roving animal and so the more free range it can be allowed the better. Many farms have fields unsuitable for anything but sheep and in such cases care should be taken not to overstock.

On dairy farms, one very important fact to be borne in mind is that sheep must not be allowed to take the valuable early spring grass required for the dairy herd; sheep must therefore be kept off cow-pastures after February.

It is on the mixed and dairy farms that we may look for an increase in the sheep population in the post-war years. Much land is already (1947) going down to grass and thousands of acres, particularly marginal land, may be laid down shortly. This land has to be stocked, and in view of the fact that for a variety of reasons much of it is unsuitable for dairying, the stocking is most likely to be sheep. There are few mixed farms which cannot run a small flock of sheep with advantage and it is on these farms that we shall expect our sheep population to be increased.

Easter Lamb Flocks.

Prior to such difficulties as those concerned with feeding-stuff restrictions, livestock prices and marketing controls, the production of Easter lamb was quite a common practice. The breed of sheep employed was often the Dorset Horn, because of its unique characteristic of coming 'on heat' from June onwards. The ewes could be mated at any time during July so that their 21 week gestation period took them to December; the actual date was varied according to the earliness or otherwise of Easter. The ewes were usually run on kale or some other suitable crop and considerable extra feeding in the form of hay (1 lb.) and concentrates (1–1½ lb.) was necessary. There could be no question of stinting the feeding, the animals had to be fed really well right through, if the lambs were to do well and so command a good price. The aim was to get all the lambs to a minimum live-weight of 60 lb. for sale just before Easter. Selected lambs from other breeds born during January reached the required weight, especially in years when Easter was late.

Flying Flocks.

This term refers to a flock of ewes which is bought in, mated, lambed and sold fat with its lambs the following summer. Any breed can be used as a flying flock, but, by reason of the sales of mountain ewes from the hills before they are worn out, it is a common practice to use these as flying flocks. They are bought in the autumn or late summer, having been very carefully looked over before purchase. On arrival at the home farm they should be treated for worms, put through a foot-rot bath (see page 615) and isolated for some time from other sheep. They are mated at the normal time and the management throughout the year is perfectly normal, but it should be borne in mind that the ewes are to be sold fat with, or some after, their lambs and they should be fed accordingly. If the ewes are well preserved they may possibly be retained for a second year. There is no reason why a lamb average of 1¼ lambs per ewe should not be obtained and very often the ewes are sold for as much or even more than their purchase price. The author knows of one farm where Welsh Mountain ewes were purchased for 45/– per head, sold the following summer for 50/– per head, having reared 1¼ lambs per head in 1947; the lambs were sold for 70/–.

Production of Sheep for Exhibition.

The principal shows in this country which concern sheep are Smithfield Fat Stock Show, the Royal Show, the Highland Agricultural Society's show, the Bath and West Show, the Three Counties Show and the individual County Agricultural Shows. The first thing that strikes anyone visiting these shows is the almost incredible skill and patience which has been used on the animals concerned. The animals' fleeces are trimmed for weeks before the show and this, of course, can disguise some of the animals' faults in conformation, though these are discovered when the judges handle the sheep in the ring; opinions differ as to whether this practice is a good one or not but, unless all breeders agree to discontinue it, the practice will go on, because trimmed sheep look infinitely better than untrimmed ones. The same may be said of dyeing the fleeces; some of the down breeds which have black faces and legs are dyed orange or yellow in colour and of the longwool breeds some are dyed khaki and some yellow. It seems stupid, but a pen of uncoloured sheep amongst coloured pens shows up very badly. It is again a question of mutual agreement on the part of all breeders before the practice can be given up; some breed societies have already taken steps in this direction.

The production of successful show animals requires a long term policy. The ewes and rams from which the exhibition animals are to be bred must be carefully selected and must be well matched. They must be mated so that the progeny are born as soon after the New Year as possible; the classes at agricultural shows are nearly always related to the year of birth of the animals and it is obviously foolish to show March or April lambs against January born lambs, except in classes for mature sheep, where differences in age are less important because with older animals some of the discrepancies should have been made good.

If the ultimate object is to exhibit a pen of several sheep the exhibitor must start with, say, twenty picked animals. Losses may occur, individual sheep may not develop as well as was expected and so it is necessary to have far more sheep to pick from than the actual number required. Similarly, for an exhibit requiring a single animal, several must be selected, fed and, indeed, in all respects, be treated in the same way. Showing, therefore, is a good deal more expensive than would appear at first sight. It is usual at Smithfield Fat Stock Show to have pens of 3 animals; the show is in December and the

classes are for sheep born during that year (i.e. from the previous January onwards) and for sheep born during the previous year (i.e. animals nearly 2 years old). The Royal Show and County Show usually have single rams and pens of 3 ewes; sometimes the ram lambs are show in pens of 3. In addition to the shows already mentioned each of the Breed Societies holds its own annual ram show and sale. In these shows there is often a class for pens of 3 or 5 rams.

The feeding of exhibition sheep is a matter of very great skill on the part of the flock owner and the shepherd. The animals must have the pick of all food available presented to them in such a way that their appetite remains good and that not a day of progress is lost through any digestive upset. Variety of diet to stimulate the appetite is all important and the time of feeding must be regular. Sheep for exhibition are sometimes housed and sometimes run out, and this depends upon the time of year and upon the owner's personal opinion. From the point of view of keeping the animals clean and controlling their feeding the indoor method is the better, but it is rather a lamentable state of affairs when rams of mountain breeds, which should be tough and hardy, are housed for a large part of their lives.

Nowhere is the skill and conscientiousness of the shepherd more vital than in the production of show sheep and when one reflects that single rams have sometimes been sold for 1,000 guineas and frequently for more than 500 guineas one realizes what an immense responsibility the shepherd has.

FOOD FOR THOUGHT

Here our author considers developments which may be made in the future.

Consumption.

THE quantity of mutton and lamb consumed per head of the population prior to the Second World War was 26 lb. per year. This is a very high figure and there is one new factor which is likely to lead to an increase in this consumption, namely that since the war more people than before are in a position to buy mutton or lamb. On account of the percentage of bone these are a more extravagant form of meat than beef. Because future incomes and purchasing powers are uncertain it would be unwise to stress the likelihood of permanence in this matter and on the whole it may seem unlikely that the consumption per head will materially increase. On the other hand, there is no reason whatever why the percentage of home-produced mutton and lamb should not increase at the expense of the imported mutton and lamb. This is entirely a question of restricting imports and of giving sufficient encouragement to our own sheep-breeders to increase the sheep production above the 1939 level; this is discussed later in this section. Alongside this increase in home production and decrease in imports we should have to establish some form of grading of the carcases and some control of the price and volume of production. The grading of the sheep or lambs should be carried out after slaughter because it is even more difficult to grade a live sheep than a live pig. This would naturally involve the establishment of a number of large abattoirs to deal with all the sheep.

It has been stated that, judging from experience in New Zealand, 22 abattoirs responsible for slaughtering sheep would be necessary to deal with the 11 million animals annually marketed in this country. They would, of course, be built at points near the centre of sheep producing areas, each serving a particular area. Each abattoir would be responsible for slaughtering the sheep sent to it, for grading the carcases and for making maximum use of all the by-products, a procedure not possible when small numbers of sheep are slaughtered at scattered points. The carcases would be marked with their particular grade sufficiently extensively for the housewife, when purchasing the joint, to have clear indication of the grade to which it belonged. The object would be defeated if the carcase was only marked in one or two places, so that an unmarked leg could be proffered to a housewife without her knowing whether it was part of an old ewe or of a young lamb. These graded and marked carcases would be sent to the wholesale meat markets in large cities for distribution to the retail trade. If all sheep passed through these large abattoirs it would always be possible to utilize ewe carcases for canning and for other special purposes. This would prevent the British housewife from buying cheap ewe mutton unless it was her wish; the sale of such meat is the chief cause of prejudice against home-produced mutton. When all is said and done the majority of the imported New Zealand lamb is Southdown × Kent cross, the equal of which is produced all over the British Isles, but in a greater variety of sizes and stages of fatness. The exact counterpart is produced in large quantities in Kent. The New Zealand carcases come into this country at constant weights; our Southdown × Kent crosses go on to the home market at carcase weights ranging from 30 lb. to 60 lb. In order to ensure a regular supply of home-produced mutton and lamb, it is obvious that some form of price fixing will be necessary, otherwise the British farmer, who is a versatile person, will very quickly turn from sheep to something else; he must be assured of a reasonable profit in cases where his management is reasonably efficient. In addition to fixing the price so as to encourage the farmer some limits must be set on supplies. There is sufficient information available to make calculation of the desirable production comparatively easy. The population of Great Britian is, in round figures, 40,000,000. Prior to the Second World War each member of the population consumed 26 lb. of mutton or lamb. If for the sake of argument the average sheep carcase is taken as 52 lb. then the country requires 20,000,000 carcases to satisfy the demand. In order to produce this number of carcases a national ewe flock of over 20,000,000 ewes would be necessary; this is a larger number than we have ever had. The 1939 ewe population was 12,500,000, and the author's opinion and the opinion of many others is that this could very easily be increased if there were an assured market and an assured price; this is more fully discussed later in this section.

Production.

The increase in the ewe population entirely depends on the Government's future policy, so does the question of limiting imports; however, it seems reasonable to suppose that the Government will find it advisable to ensure the continuance of a healthy and prosperous British agriculture. This is necessary for a number of reasons. We have very little money to spend abroad, and in the case of many agricultural commodities frequently obtained overseas before 1939 (sheep less than others) the countries of their origin often now need more for their own use or for alternative markets. The reasons for this include increasing populations in many countries and the exhaustion of fertility on much of their soil which remained virgin land until comparatively recent times.

The problem of increasing production in Great Britain is an absorbing one. Firstly, the decision has to be made with regard to the foodstuffs we intend to produce for ourselves. If it is decided

that sheep are to play an important part in national production a constructive policy must be worked out for them and this must be based upon land reclamation and the improvement of hill and mountain grazing. There are still huge areas of land capable of reclamation and large areas of hill and mountain land capable of improvement, though, in many cases, the owner has not sufficient capital to carry these improvements out and would therefore need assistance from the Government. Reclamation and improvement are more than ever necessary as satellite towns, motor roads, military training areas and airfields eat up agricultural land. Fruit and market garden crops are increasing on the better types of soil so that sheep are constantly losing available land.

Assuming that the Government decides to pursue a progressive policy of production and that the farmer knows that there is a guaranteed productive price in exchange for reasonable efficiency, what are his problems of production?

He must first select a suitable breed for his purpose and from the particulars given in Section II, a breed can be chosen for almost any set of circumstances. Prolificacy in lowland breeds is of paramount importance. Few of the breed societies can give official figures for the lamb average of the breed, but it is well known that the variation is very great. The hill and mountain sheep farmer is happy with a single lamb but the lowland farmer should aim at an average of 150 lambs reared for every 100 ewes mated. This can be achieved in one of two ways. Ewe lambs or ewe tegs (gimmers) of a prolific type of crossbred sheep can be bought, and examples of this, which immediately spring to one's mind are the Border Leicester × Cheviot (Half-Bred), the Wensleydale × Scotch Blackface or Wensleydale × Swaledale (Masham) or the Border Leicester × Scotch Blackface (Greyface). The other alternative is to increase the prolificacy of a pure breed by the selection of the breeding stock from twins. The first method is one which is very commonly practised at the present time and one which gives great success with efficient management. The Wye College farm has for a number of years averaged almost 150 lambs reared for every 100 Border Leicester × Cheviot ewes mated; sheep purchased at the same time by the College Farm Manager in Scotland for other farmers in Kent have produced indifferent results, and this presumably has been due to lower efficiency in feeding, in management at lambing time, and in shepherding; some farmers in Kent on the other hand have achieved results as good as those on the College farm.

The second method of increasing prolificacy by selection is a slow method requiring patience over a number of years. The ewes retained for breeding should be from twins and the rams bought for breeding should be twins also. The ewes and rams which are themselves twins, naturally have more chance of producing twins than ewes and rams which are singles. The increase in lamb average year by year will, of course, be small, but with perseverance an increase can be obtained. There are two important warnings which should accompany this suggestion: firstly, the retention of twins must neither be allowed to bring about a reduction in size of the ewes nor any loss of constitution; and secondly, it is useless to encourage the production of twins unless the milking capacity of the ewe is sufficient to rear them. When selecting ewe lambs to retain for breeding the milking capacity of their mother must also be considered. The milking capacity of a ewe can be gauged from the progress of the lambs, the size of the udder and other observations of flockmaster and shepherd.

The aim with a grass flock should be to have as many ewes as possible producing two lambs each, to rear them well and for the lambs to reach a live weight of about 90 lb. in 18 weeks; birth-weight of the lambs will average about 9 lb. and the live weight increase per week will be some 4½ lb.

It would be possible to arrange for a regular supply of British lamb by the use of Dorset Horn ewes which can produce lambs all the year round, or by breeding from Dorset Horn crossbred ewes some of which would have inherited the Dorset Horn characteristics or by selection within one of the other breeds. In an investigation into the breeding habits of Kent ewes the author found that Kent ewes come on heat in September and although some of them cease to do so in early March others continue until the end of March. It would thus be possible to mate Kent ewes from September to the end of March to lamb from February to the end of August to produce marketable lamb from the end of June to the end of December. The gap between January and June could be bridged by the use of Dorset Horn flocks so that in fact lamb could be produced in this country all the year round. The author can imagine the comments of farmers who have read thus far. They will be scathing upon the subjects of an all the year round lambing time, the upset in the flock routine, the heavy feeding required for pregnant ewes, due to lamb outside the grass season or suckling lambs then! To such difficulties must, I know, be added that of labour which is the next note on the author's list of items to discuss. This question is fully considered towards the end of the present section, under the heading of "LABOUR, CAPITAL AND RETURNS", pp. 624–626, but it must be mentioned here as one of the most serious snags to any attempt to organize an all the year supply of British lambs.

WOOL

Under this heading the following topics are considered:—Types of wool and hair used in commerce. The world's wool production. History of the use of wool. World wool consumption. Composition of Wool.

Wool and Hair Producing Animals.

THE GOAT. The familiar British goat is kept solely for milk production and not for the use of its coat. In other parts of the world the coat is used; in Arab countries the hair from their black goats is woven into the tents used by the Bedouins and in the hills and mountains of South Africa, U.S.A. and Asia Minor the *Angora* goat is kept for its coat. During the warm season, the Angora, which is a large animal, grows a short woolly fur of a greyish brown colour. In winter this becomes covered with long and bright hair of remarkable lustre, which is known as *Mohair*. Some of this finds its way to manufacturers in this country, where it is used for making braids, laces, upholstery fabrics, hats, light-weight suits and draperies and for the linings of clothes. It is the most important of the animal fibres (other than wool) used in textile industries. The weight of mohair produced by each goat is about 4 lb. a year and the price in London is about the same as that of the lower grades of British wool. The other type of goat for whose coat there is a commercial demand is the *Cashmere*. The coat of this goat has an outer covering of long, straight hair with a fine, soft undercoat, commercially known as Cashmere. This is specially suitable for shawls, scarves, cardigans and underwear, and is sometimes mixed with sheeps' wool. The Cashmere Goat is bred in Tibet, Kashmir and China and has not been acclimatized elsewhere. The quantity obtained from each goat is extremely small (3–4 oz.) though annual exports from China alone have on occasions reached 3 million lb.

THE CAMEL produces on part of its body a woolly hair, which is of importance in the textile industry for hosiery, blankets, rugs, underwear and for special effects in tweeds and greatcoats. The fibre is produced by the Bactrian camel from China and Russia. The Chinese camel yields only 6½ lb. of hair per annum. Most of this fibre was formerly exported to the United Kingdom. The fibre is very soft, though coarser than the Cashmere goat or the Vicuna to be mentioned later (see below).

THE ALPACA is a domesticated animal kept solely for the fibre it produces, though shearing only takes place in alternate years. The fleece is soft, elastic and lustrous (softer than Mohair but not so lustrous). In colour the hair is brown, grey or black with some white fibres. It is used in dress fabrics and linings, the principal market being the United Kingdom; South America, particularly Peru, is the most important area of production. The annual average for each animal is about 1½ lb. (3 lb. every other year) and the total exports amount to about three million lb. per annum.

THE VICUNA, a wild animal about the size of a sheep, is hunted for the sake of its wool, which is not only fine, silky and lustrous, but has good felting qualities (see glossary to this section). The hair is the finest of all animal fibres and is used with wool for the weaving of the finest cloths. It is scarce and like other natural fibres is suffering from competition with those artificially produced. It is fawn or light brown in colour and comes mainly from Peru.

THE LLAMA is a beast of burden in Peru; its wool which is coarse and non-elastic, is used for making carpets.

The World Wool Production.

Wool is next to cotton in importance as a raw material in the textile trades, and among the manufacturing industries of Great Britain that of wool is one of its largest and most important. The wool trade is one of the strongest links of empire, because three Commonwealth countries are among the first six great wool producing countries of the world as can be seen from Table 7. Our wool industry employs directly about 250,000 people and many others gain indirect employment.

TABLE 7

PRODUCTION IN 1930 OF GREASY WOOL IN MILLION POUNDS

Countries	*Million lb. of Wool*
Australia	901
U.S.A.	434
Argentina	329
U.S.S.R.	300
South Africa	290
New Zealand	266
Uruguay	154
United Kingdom	120
China	53
Algeria	49
France	45
Germany	32
India	30
Turkey	22
Canada	21

Australia, which is so far ahead of any other country in wool production, carries nearly half of its sheep in New South Wales, nearly one quarter in Queensland, one seventh in Victoria, one tenth in Western Australia, one eighteenth in South Australia and one fiftieth in Tasmania. A flock in Australia may total 50,000 sheep and a few flocks even more than this. South Africa's sheep population is found mainly in Cape Colony and the Orange Free State, with much smaller numbers in Transvaal and Natal. New Zealand,

which has the densest sheep population in the world, divides its flocks almost equally between the North Island and the South Island. The distribution of sheep in the United Kingdom has already been discussed and is shown on the map on page 579. The sheep population of Canada may seem at first surprisingly low. This is explained by the severity of the winter which necessitates the housing of the sheep for several months of the year. The number of sheep in Argentina has fallen very heavily during this century and this has been due, in the main, to the increase in cattle raising. Uruguay has a sheep density almost as great as that of New Zealand. The U.S.A. actually had more sheep in 1884 than at any subsequent time, but the population of sheep since 1922 has increased steadily until the total is now almost up to the 1884 level. Outstanding amongst European nations is the U.S.S.R.; though the actual figures are somewhat shrouded in mystery, it would appear that there are well over 100 million sheep. Spain and Roumania also carry considerable flocks. It is surprising that France, relying perhaps upon production in nearby Algeria, has such a small number of sheep if we take into account the area of the country and the size of its human population. The same surprise awaits us to an even greater extent when we consider Germany; here, intensive development of other forms of agriculture had already driven the sheep population down to about three million before the Second World War and presumably it has now been depressed much more. The numbers of the sheep population of China are as obscure as those of the human population, but are estimated to have been about 45 million in 1930, and there are probably fewer sheep now following the prolonged Japanese war.

History of the Use of Wool.

Wool has been used for human clothing since the days of prehistoric man; at first it was used on the sheep skin, but later the wool was removed from the skin. To-day in some Southern European and Arab countries the sheep skin with its wool attached is still used; woven wool cloth is also used to give protection from the sun by day and from the cold of the desert at night. As early as the seventh century before Christ, wool was being spun and sold as homespun and certain dyes had been discovered. The ancient Britons had learned the art of spinning and dyeing wool before the arrival of the Romans in A.D. 43. Until 1331 wool was of great importance in this country, but it was woven in the Netherlands; in 1331 Edward III imported Flemish weavers, and from that time onwards our woollen manufacturing industry was built up until 80 per cent of our exports were woollen goods in the time of Elizabeth. The use of wool in many parts of the world has increased and countries in the Far East (Japan, China, etc.) now use wool where previously only cotton and silk were used; the consumption of wool per head of population in different countries can be seen in Table 8. About 7 lb. of Greasy wool are needed to make an adult suit of clothes so that there is still room for vast increased consumption in every country in the world.

TABLE 8

ANNUAL CONSUMPTION IN POUNDS PER HEAD OF POPULATION OF GREASY WOOL IN YEARS BEFORE THE SECOND WORLD WAR

Belgium	9·4
United Kingdom	8·8
Australia	8·6
France	7·8
New Zealand	6·4
South Africa	5·0
Argentina	4·8
Germany	4·1
U.S.A.	4·1
Italy	4·1
Japan	2·7
U.S.S.R.	1·6
Poland	1·4

World Types of Wool.

In Australia about 75 per cent of the total wool production is Merino, though its actual proportion to other kinds has varied considerably during the present century. On account of very low rainfall and scant herbage, certain parts of Australia are suited only to the production of Merino wool, and these regions could not support the usual types of sheep originating mainly from crossing British breeds with the Merino. In South Africa the proportion of Merino types to others is even higher, reaching over 90 per cent of the total. In New Zealand most of the sheep are British in origin (chiefly Romney Marsh) or spring from British sheep crossed with Merinos, the most notable example being the Corriedale, which began as a Lincoln and Merino Cross. Originally, New Zealand farmers bred Merinos almost exclusively but when the frozen lamb trade expanded, it necessitated a change to a type of sheep with a better carcase. In Argentina in 1930 roughly one third of the sheep were Merinos and the rest were Lincolns and Romney Marsh. In Uruguay the breeds were roughly the same proportions. Most of the sheep in the U.S.S.R. are coarse woolled; of Spain's sheep population Merino accounts for one quarter while three quarters of the animals are coarse woolled.

The fineness of wool is usually measured by the number of hanks (560 yards) of spun wool which can be produced from 1 lb. of the scoured wool concerned. Thus a fleece that is said to be 40's will give 40 hanks from every pound of scoured wool.

Broadly speaking, the world's wool can be placed in three grades: Merino (60's to 100's), Crossbred (36's to 58's) and Carpet (22's to 34's). Merino wool is thus the finest and more hanks, often many more, can be spun from a pound of it; 'Crossbred wool' is not necessarily from the fleece of a crossbred sheep and the expression merely implies something intermediate between Merino and Carpet wools. The allocation of the world's wool crop of 2,799 million pounds in 1915 amongst the three groups was as follows: Merino 1,075 million lb., Crossbred 1,022 million lb., and Carpet 702 million lb. (1932 Wool Survey by Empire Marketing Board).

There is no Merino wool crop from the United Kingdom and much the greater part of her wool production falls into the crossbred group of the world classification. In a national grading, the wools of the United Kingdom are divided into three sections: (1) longwool (2) shortwool or down, and (3) mountain.

Longwools are characterized by length of fibre, which often reaches 12 in., by strength of the individual fibres and usually by lustre, which can best be described as polish on the surface of the fibre. This classification is most commonly used in the worsted trade (see later under the present heading, p. 611), which requires long fibres, which during manufacture can readily be arranged parallel to one another. Their natural lustre leads to the use of these wools where some brilliance and measure of stiffness is required, as in braids, linings, dress materials, alpacas and suitings. The less lustrous of the longwools, known as demi-lustre wools, are used for serge, tweed and blankets. All the long-wooled breeds, which are described in the paragraphs dealing with "Breeds of Sheep", pp. 578–590, come under this heading as well as some of the Down × Longwool Crosses. The quality is 36's–46's.

The Down or Shortwools are much shorter in fibre, but are finer, more elastic and softer than the longwools; they are not lustrous. Their fine grade makes it possible to use them for the manufacture of lightweight materials. All the down breeds described under "Breeds of Sheep" belong to this group, the quality being 50's–56's. Their chief uses are in the manufacture of flannels, underwear, knitting wools and the finest dress materials.

The Mountain Wools are subject to considerable differences in different parts of the fleece and frequently there is an undercoat of short, finer wool below the long coarse fibres which may reach as much as 12 in. in length. Frequently some black fibres are present as well as some short, white hairs known as Kemps; neither these black fibres nor the Kemp will take the dye properly, and their presence constitutes a serious drawback for all purposes except rough tweeds. These wools lack brightness and are used for tweeds, coarser cloths and wools, coarser blankets and carpets; the coarser parts of the fleece may find their way into the carpet trade. In quality they range from 32's to 46's.

The foregoing account given as it is in rather general terms may convey the impression that the quality of the fleece is the same all over and that it is used in one piece. In practice the manufacture of a particular article may require wool from one part only of the fleece of a certain breed; one manufacturer may want the shoulder wool from Southdowns, from another there may be a demand for the britch wool from a Lincoln, the wools in question possessing the exact qualities required by the particular manufacturers. This will become clearer as the description of the processes from sheep to finished garment proceeds.

From Shearer to Grader.

The shearing process has already been described in the part of this section headed "The Sheep Year", pp. 591–598 and we must now follow the progress of the fleece from the time the shepherd rolls it up until it becomes a finished manufactured article. The flockmaster must decide whether he will dispose of his wool through one of the co-operative wool marketing organizations, which exist in many parts of the country, or sell it to a local wool merchant, who in his turn finds a suitable buyer in Bradford. In either case wool sheets which hold 40–60 fleeces each are sent to the farm; into these the fleeces are packed and the sheets are sewn up. The wool should be trodden down as tightly as possible to avoid using too many sheets. The sheets are delivered to the station or to the merchant or co-operative graders by lorry or rail. The wool now comes under the eye and hand of the grader. The most important factor for which he looks is the *fineness* of the fibres, since a much longer thread can be spun from a given weight of fine wool than is possible with coarse wool. *Strength* is important, but this is usually satisfactory except where a check in growth has been caused by hunger, severe drought or disease. During such a check in growth the wool fibre produced is brittle and this will show in the wool staple as a weak place. If the two ends of the staple are pulled the wool will break at the weak point and this is a serious defect. *Length* of the staple depends, of course, on the breed, but a grader will also look for what is known as a 'tippy' staple, that is to say one which tapers to a point and consequently contains fibres of differing lengths as opposed to a square-ended staple in which the fibres are of the same length. Other things being equal, the longer the staple the better. *Lustre* is also dependent partly upon the breed and cannot be expected from Down wool. *Elasticity* is dependent upon the amount of crimp or wave in the wool, the crimpy samples being the more elastic. *Colour* should be uniform and free from any black or brown fibres. *Cleanliness:*

The wool should be free from such dirt as vegetable impurities, sheep manure and tar markings and should not be exceptionally heavy in grease. The grader will note whether the fleece is exceptionally greasy; normally greasy or washed. If washed sheep are left too long after washing before they are shorn they may be classified as greasy by the grader. One of the old fashioned Merino wools from a very dusty part of the world was once described as "dirt and grease with just sufficient wool to hold them together."

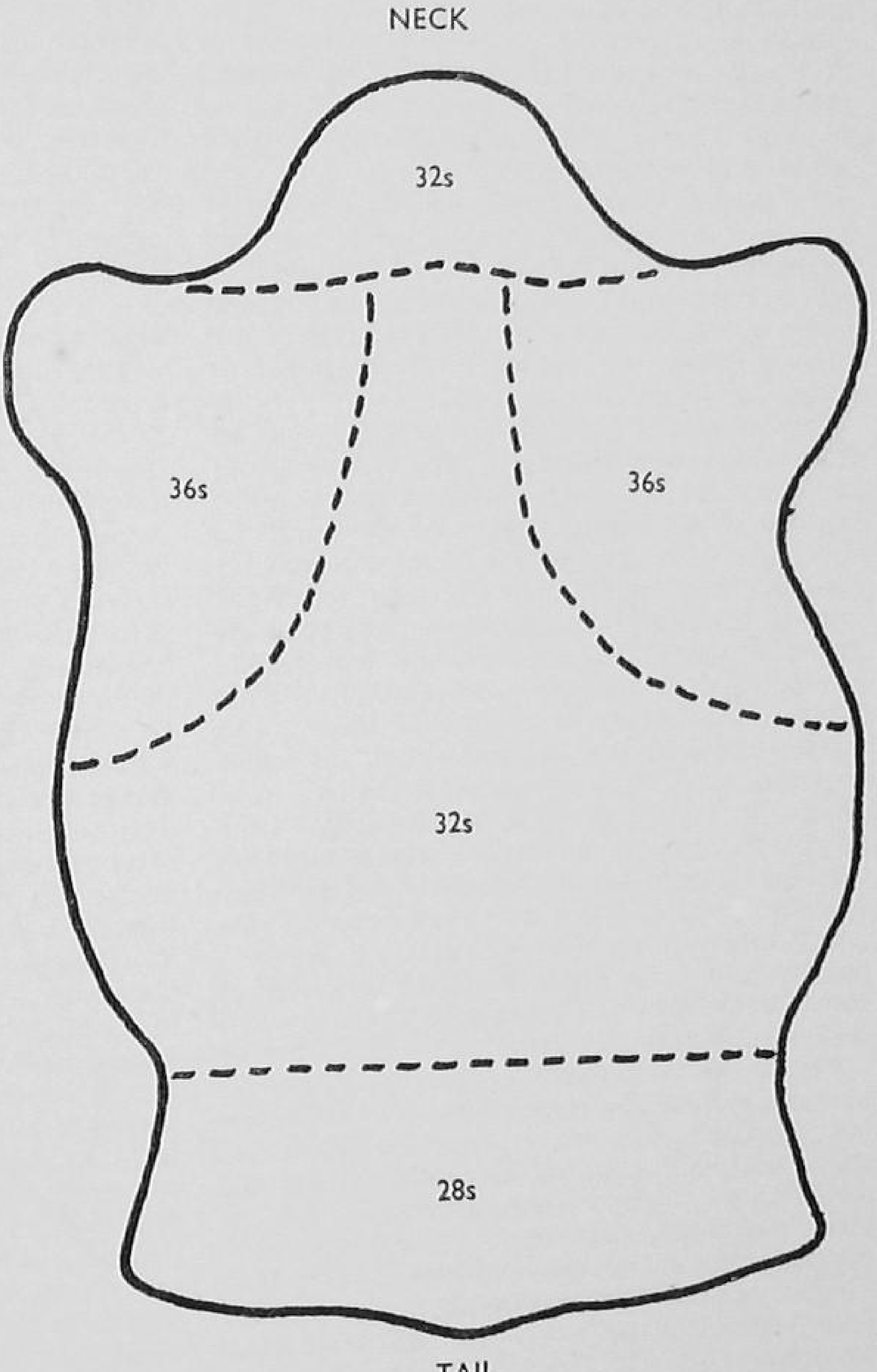
Packing.

On the part of a practised grader consideration of each fleece takes only a matter of seconds; the fleece is then put into one of many labelled wheeled baskets, which stand round the grader's table. As the baskets are filled with fleeces of different grades they are wheeled away and the fleeces stacked with thousands of others of the same grade. In due course, when a sufficient quantity of each grade has accumulated, baling begins. A wool bale consists of a rectangular jute container fitted inside an iron-bound, wooden frame of the same shape. Alongside this wooden frame and hinged to it is a similar frame. Both frames are packed as tightly as possible with the graded fleeces. The fleece-packed frames are then placed one upon the other and by means of a ratchet and levers the contents of the upper one are pressed down into the lower and thus into the jute container. The levers are worked by two men and the job is extremely hard work, especially at the end of each bale, when the final compression requires a great deal of effort, and incidentally, there are now power-driven balers on the market.

When all the fleeces have been pressed into the jute container a jute top is sewn on to the top of the bale before the pressure is released. The bales thus made contain about 60 Kent fleeces, Southdown fleeces and other breeds *pro rata;* the weight of a bale is approximately 3–4 cwt. Bales are stamped with the mark of the co-operative society concerned and are stored until they are to be offered for sale on the London market; then about 10 per cent of each consignment will be sent to the sale as a sample.

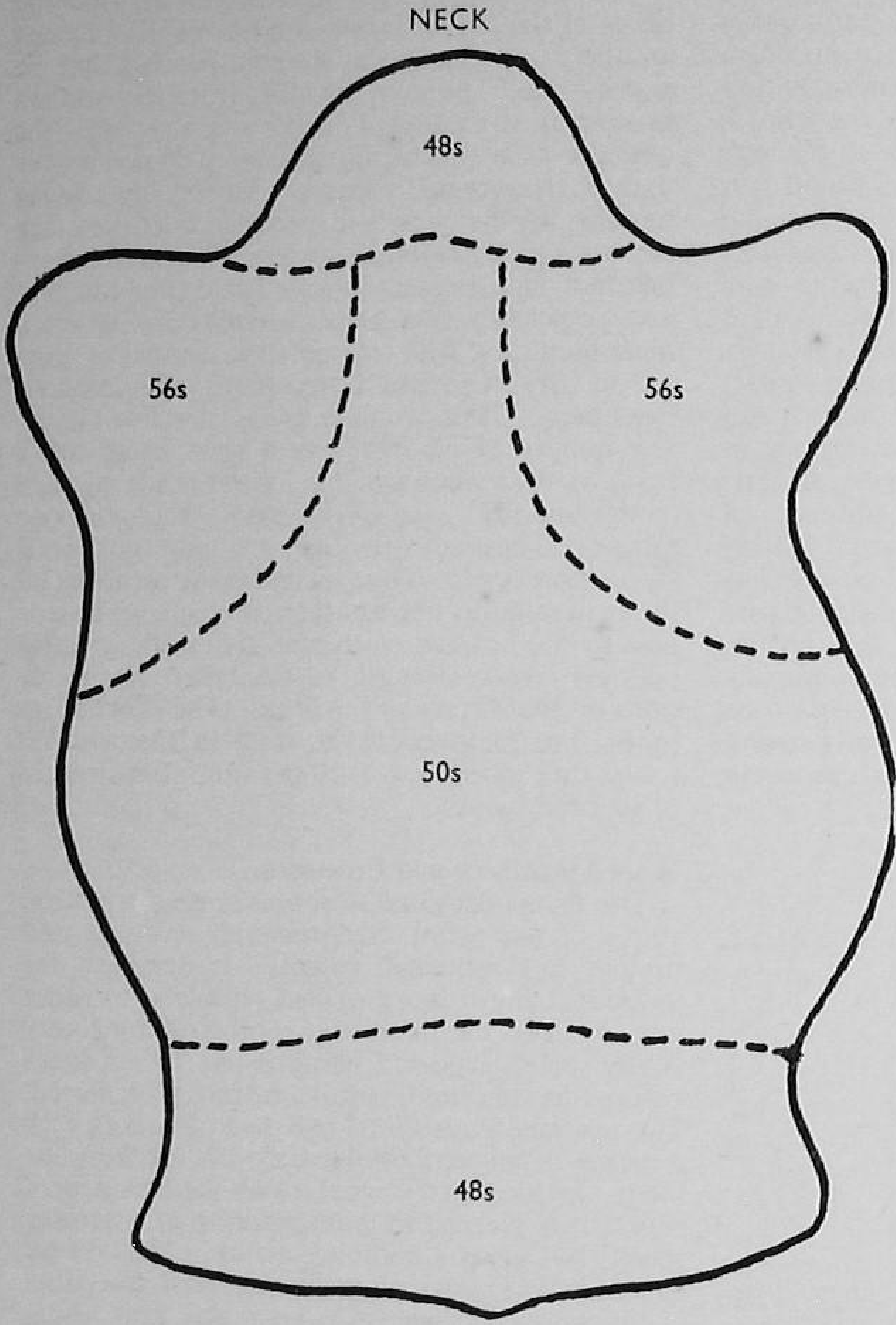
Marketing.

The Wool Exchange in Coleman Street, London, attracts buyers from all parts of the world, and these buyers are naturally more likely to be interested in a bale of properly graded wool than they are in consignments of ungraded wool, which probably contain many fleeces quite useless for their particular purpose. The co-operative societies have the advice of a wool broker as to when they should market a particular grade of wool and they market it in sufficiently large consignments to attract the largest buyers. Overseas buyers will only buy baled and graded wool. The society naturally makes a charge to wool growers for the services it renders in grading, baling and marketing the wool, and this



HOW A MOUNTAIN FLEECE IS SORTED
FIG. 13.

charge works out at about 1d. per lb. of wool. Some of these co-operative wool marketing organizations handle over ¼ million fleeces annually; the Kent Woolgrowers Ltd. handle fleeces mainly from Kent, the Southern Woolgrowers at Chichester handle fleeces mainly from Sussex and Hampshire, the Central Woolgrowers at Nottingham from the Midlands, East Anglia and Lincolnshire and the Northern Woolgrowers Ltd. at Malton handle them from Yorkshire.



How a Southdown Fleece is Sorted
Fig. 14.

Sorting.

It has already been pointed out that only a part of a graded fleece suits the requirements of the individual buyer. On arrival at the Bradford Mills, or shall we say the West Riding Mills, because one automatically thinks of Bradford as being synonymous with woollen mills, the fleece has to be sorted into its different grades. Figs. 13 and 14 show the division of a Mountain fleece and a Down fleece into their various qualities. It will be seen from this that the finest wool grows on the shoulders of the British breeds, the next quality is on the back and flanks and the lowest quality on the belly and britch. The Merino fleece is much more even in quality and often the only sorting carried out is on the farm, where the skirt is taken off the fleece, thus removing the belly and britch; the remainder is marketed as one grade. Many wool manufacturers who handle British fleeces are making an effort to use a large number of British fleeces in bulk as one grade, so as to save some of the cost of sorting. It should be pointed out here that many mills specialize in one particular phase of manufacture and do not start with the raw wool and end with the finished material. Thus a manufacturer who deals only with the first few processes, about to be described, can deal with a number of different grades of wool prior to disposing of them to those responsible for the later processes. The manufacturer who starts with the raw wool and finishes with a finished article requires only one grade of wool.

The sorter works in front of a table about 4 ft. high, the top of which consists of a strong wire screen of 4 in. × ⅛ in. During the process of sorting some dirt, including dust and short pieces of straw fall through the mesh on to the floor and the larger pieces of straw, twine and twigs are pulled out by hand. Badly soiled wool, including dungy pieces, are separated from the rest. The table ought to be in good light but not in direct sunlight, so that the grader can see well to sort out the various parts of the fleece already mentioned (shoulder, back and flanks, britch, belly, short pieces, soiled, and so on). These are placed in large wheeled baskets.

Scouring.

In this process the wool is almost completely cleansed by passing it through three tanks—two scouring tanks and one rinsing tank. The tanks

are about 20 ft. long and each holds some 1,500 gallons of liquid. The first tank contains 1,500 gallons of water at a temperature of 125° F., 100 lb. soap, and 15 lb. sodium carbonate. The wool is laid on an automatic feeder and being carried into the tank is moved through it by a number of forks mounted on cranks dipping into the liquid and moving forward a short distance and then lifting out and going back to repeat the process. The passage through the tank takes about 2½ minutes and the atmosphere in which the operators have to work is extremely unpleasant. At the end of the first tank the wool is carried up an incline and having passed through rollers which squeeze out the surplus liquid it is deposited in the second tank. This tank is similar except that only 60 lb. of soap are used and only 5 lb. of alkali. After another squeezing the wool enters the third tank in which there is no alkali at all and in which the soap is reduced to 10 lb. After squeezing again the wool is 'scoured wool'; it still retains the form of its staple and so it still contains some dirt and grease in the interior of the staple (see later, page 612). The liquid lasts from ½–2 days according to the amount of dirt in the wool being scoured. A mill dealing with large quantities of Merino wool usually has a plant to collect the grease for the manufacture of such preparations as 'Lanoline' face cream. The yield of scoured wool varies tremendously and is reputed to range from 25 per cent to as much as 70 per cent of the weight of raw wool. An estimate of the average loss through scouring (shrinkage) is shown in Table 9.

TABLE 9

PERCENTAGE LOSS OF GREASY FLEECES WHEN SCOURED

English long lustre	20
English medium	21
English down	25
Low crossbred	22
Medium crossbred	30
Fine crossbred	35
Merino	55

Fleeces naturally washed, on the farm, lose much less on scouring, much of the dirt and grease already having been removed. Farms on clayey soils produce dirtier wool and wet seasons tend to give cleaner wool, some of the dirt being washed off.

Drying.

Merino wools do not need drying because after being squeezed as they leave the scourer they contain only sufficient moisture to make them work properly in the 'carder' and in any case some drying takes place as the wool is blown along tubes by blasts of air (the accepted way of moving wool about the mill). Crossbred and English wools require drying and this is done by placing the wool on moving lattices through which hot air is blown; the speed of the lattices can be varied to regulate drying.

From this stage the woollen and the worsted processes must be discussed separately.

The Woollen and Worsted Processes.

The Woollen process means, briefly, that the fibres of the finished yarn are not parallel to one another, whereas in the worsted process they lie side by side. The yarn resulting from the woollen process is naturally of larger diameter and the operations in producing it are fewer in number than in the worsted process. All the short fibres remain in the woollen process but they are removed in the worsted process. Woollen manufacturers have proudly boasted that they can spin any fibre with two ends, whereas the worsted manufacturers, who at one time needed at least a 3-in. fibre can use 1½-in. fibres with modern machinery. The woollen trade can use almost any quality of wool, the best yarn being made from Merino wool and the lowest grade of yarn from shoddy (see Glossary), mungo (see Glossary), a small quantity of good wool, noils (short fibres), etc. The worsted trade arranges all fibres parallel to one another, thus giving brightness to the finished cloth and giving the greatest possible tensile strength because there are serrations on the surface of the fibres. The short fibres (noils) are removed to be used in the woollen trade; they amount to 5–10 per cent of the weight of scoured wool.

Wool Machinery and Processes.

THE PREPARER GILL BOX breaks up the natural staple of any wool that, through scouring and drying, has remained intact. It arranges the individual fibres more or less parallel. In order not to break the fibres the process is done very gently, being repeated perhaps five or six times before the required parallelization is achieved. The machine consists of two sets of rollers with a series of pinned steel bars working between them. As soon as the wool leaves the first pair of rollers it is pierced by pins working at a greater speed; this gives a combing action. The second pair of rollers, working still faster, have the effect of drawing the wool through the pins, thus producing a further combing action. This action is used in the worsted process. The *Carder* consists of a number of cylinders of different diameters, running at different speeds and in different directions. The cylinders are covered with an arrangement of bent wire teeth set in leather. The work of the machine is to disintegrate completely the staple and divide the fibres from one another. The staple is collected by the last roller of the machine and emerges in the form of a continuous sliver. This procedure is used in the woollen process. *Backwashing:* When the scoured wool has been

thoroughly opened in the carder or gill box it is dun-coloured, due to the appearance of dirt brought from the centre of the staple during the scouring of the wool. The machine consists of two bowls, the former containing soap and the second water alone. Suitable feed rollers carry the sliver into the machine and under the sud, next between rollers and then through the rinsing water; it is squeezed after passing through each bowl. This procedure has to be carried out in both the woollen and worsted processes. *Combing:* The Noble Comb has a very complicated construction and is used in the worsted process. It removes the short fibres, kemps and broken fibres, and assists in completing parallelization; the remaining long fibres are delivered as a continuous sliver. *Drawing:* The object of this operation is to reduce a 'top' or thick sliver to a 'roving' or thin sliver small enough to be spun into a fine yarn. The principle of the machine is the employment of two rollers, the second one working faster than the first one so that a pull having been given to the wool, it leaves the machine untwisted and can be wound in that state on to a bobbin. *Spinning* machines pull the roving, thus reducing it in diameter, then it is twisted to add strength. It is very important that there should be no defects now, as this is the last stage of manufacture before the yarn goes to the looms. *Condensing* follows carding in the woollen process. As the wool leaves the carder it is spread over the last roller in a uniform film. The condenser divides the film into a number of small uniform strands, which are not twisted but have the fibres arranged crosswise so that they have sufficient strength to stand spinning without breaking. *Weaving* is the conversion of the finished yarns into cloth. The threads fixed in the machine and running lengthways are known are known as the Warp, whilst the threads carried across by the shuttles are known as the Weft. The warp threads can be raised individually or in any selected grouping so that the shuttle carrying the weft can be made to pass under or over any planned combination of warp threads. By the selection of this combination of warp threads the pattern of the finished cloth is made. Several shuttles carrying different weft colours can be employed.

There are two classes of worsted yarn: (1) *A lustrous yarn made from long wool by gilling;* this is suitable for cloths where brightness of surface is as important as warmth or even of greater importance and for this trade lustre and length are the most valuable assets. (2) *A Merino worsted yarn made from short wool prepared by Carding:* This has little lustre, is very soft to handle and is suitable for light and medium weight cloths in which softness and warmth are desirable features. There are thus three chief processes—those of woollen, long worsted and short worsted manufacture. The stages through which the three processes are carried out are more easily understood in tabular form (see Table 10).

TABLE 10

Woollen Process	*Long Worsted Process*	*Short Worsted Process*
Sorted	Sorted	Sorted
Scoured	Scoured	Scoured
Dried	Dried	Dried
Carded once or twice	Prepared by about 6 gill boxes	Carded once or twice
Backwashed	Backwashed	Backwashed
Dried	Dried	Dried
Condensed	Gill box	Combed
Spun with mule	Combed	Drawn
	Drawn	Spun
Woven	Spun	Woven
Washed	Woven	Washed
Dried	Washed	Dried
Ironed	Dried	Ironed
Rolled	Ironed	Rolled
	Rolled	

During the process of carding or gilling it is possible to incorporate camel hair or any other fibre required in the finished product. In the manufacture of 'natural' coloured woollen underwear a strand of brown camel fibres is mixed with 4–6 white wool fibres.

Wool Collection.

An exhibit of wool from the various breeds and crosses forms one of the most interesting collections of agricultural material that can be made. It was possible before the war to buy sheets of grease-proof blue paper on which staples of wool could be mounted. From the edge of the blue sheets a thin strip about ⅛ inch wide could be cut; on either side of the staple of wool slits ½ inch wide were made and through them the strip of paper were threaded passing over the staple of wool so as to hold it firmly. Such a collection starts with local breeds and can be increased either by correspondence or by visits to farmers, who are generally willing to contribute additional specimens. The sample should always be labelled to show the part of the body from which it was taken and if only one specimen is collected it should be from the shoulder. Moth will quickly ravage such a collection of wool unless D.D.T. dust or some moth repellent is used.

Fleece Testing.

In 1931, as a result of complaints from English manufacturers that much of the New Zealand clip contained hairy fibres, the Massey Agricultural College of North Island, New Zealand, evolved a technique for detecting hairy fibres in wool. These fibres were not kemp and were not detectable by eye and it is also certain that the New Zealand

wool was not the only offender in this respect. The coarsest parts of a fleece which were likely to contain hairy fibres could be detected by eye, but the slight tendency to hairiness could not; the detection of this slight hairiness was of course particularly important in ram fleeces. The technique evolved was cheap and simple and could be used on the farm. The hairy fibres are known as medullated fibres because they contain a medulla, that is an air-filled core, whereas pure wool contains no medulla. This core may be present in a fibre throughout its length or only in some parts of the fibre.

The principle of the test is that pure wool is invisible when immersed in benzol, whereas even slightly hairy fibres remain clearly visible on account of the air they contain in the medulla. The wool is first rinsed in petrol to remove the grease and is then immersed in benzol (not benzine, petrol or any other motor spirit) in a glass dish about 10 in × 8 in. The wool is covered with a sheet of ¼-in. plate glass fitting inside the glass dish. The under-surface of the dish should be painted black with enamel. The locks of wool selected should be cut off close to the skin and it should be emphasized that adjoining staples may differ considerably. A number of samples should be taken, the samples should be taken at different points along the shoulder and flank and samples should also be taken from the britch and from the belly. It has been suggested that 18 samples should be taken, the samples may be cut off and put between the sheets of a marked notebook, to save the marking of the individual samples.

More recently in New Zealand, where these tests have been regularly carried out in large numbers, a more rapid method has become necessary and an instrument called a medullometer is now used; this gives a direct reading of the amount of medulla present by the use of a photo electric cell.

TABLE 11

Number in Figures 15 & 16	*Kent Woolgrowers' Grade*	*Bradford Quality*	*Length of Staple*	*Diameter of Fibre*
Not included	C^1, C^2	50's	Short	1/795"
1	C^3, C^4, C^5	48's–50's	Short	1/744"–1/795"
2	C^6, C^7, C^8	46's–48's	Short	1/696"–1/744"
3	C^9, C^{10}	48's	Long	1/744"
4	C^{12}, C^{13}, C^{14}	46's	Long	1/696"
5	C^{15}, C^{16}	44's	Long	1/648"
6	LG, OG^1, OG^2	44's, 40's, 36's	Long	1/648", 1/595", 1/470"

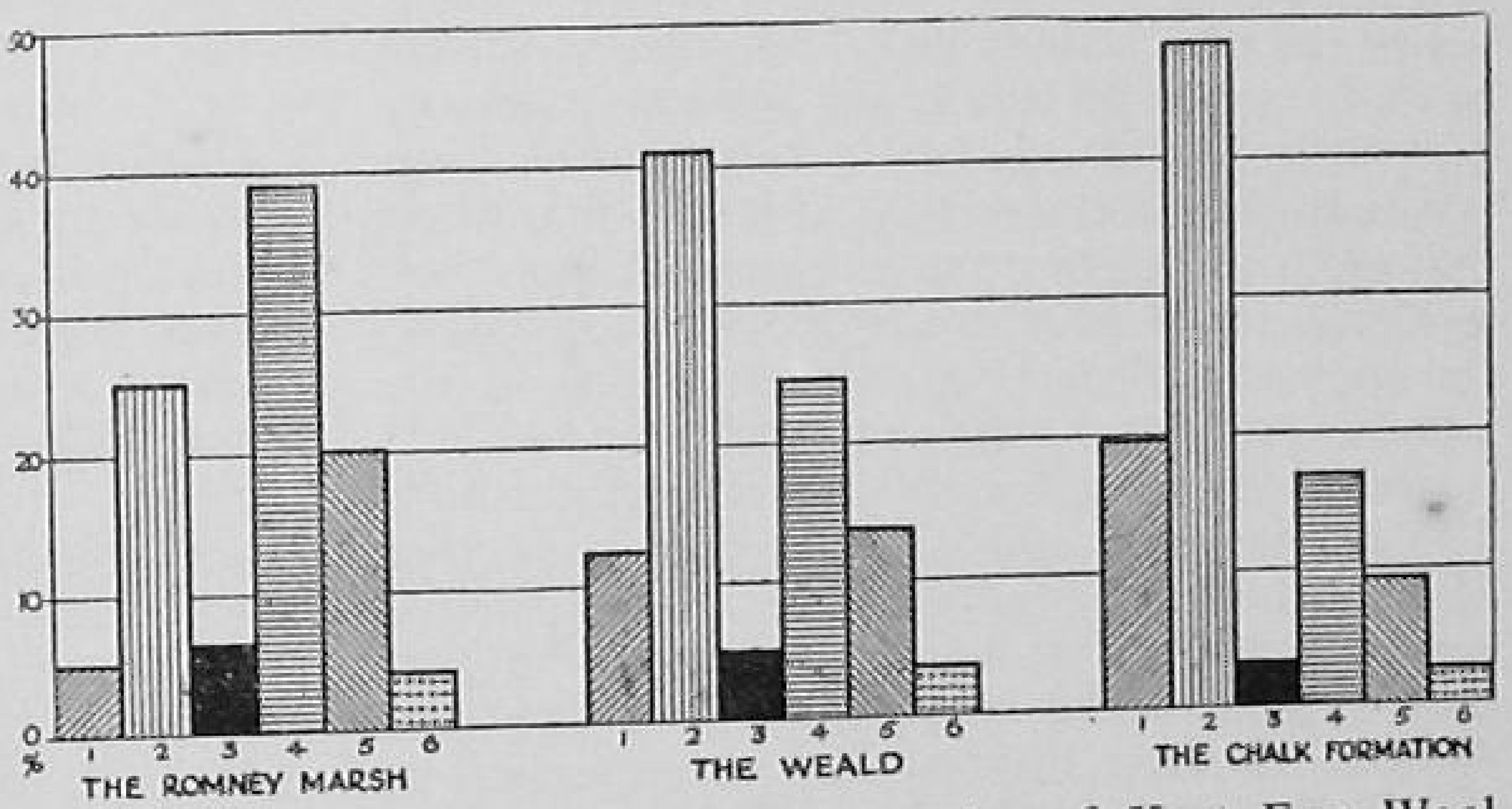


FIG. 15. The percentage of various grades of Kent Ewe Wool produced on Romney Marsh, the Weald and the Chalk Formation during 1927, 1928 and 1929. The numbers at the foot of the columns refer to the grades in Table 11.

Effects of such factors as Soil, Climate and Age upon Quality of Wool.

The author has had excellent opportunities of studying the effect of soil and climate on wool quality through the co-operation of Kent Woolgrowers, Ltd., and the results, although relating only to one breed serve to illustrate the effects on wool generally. Kent greasy ewe wool is graded by eye and touch and each fleece is placed in one of eighteen grades. A study of this table in which these grades are shown is necessary for a clear understanding of Figures 15 and 16.

Three clearly defined districts of Kent (the Weald, Romney Marsh and the Chalk areas) were selected in order to study the effect of soil and climate on wool grading. Consignments of wool from 150 farms in these areas were studied and the results are shown in Figure 15. It will be seen that the Chalk formation produced a greater proportion of the finer grades of wool and Romney Marsh a greater proportion of the stronger, coarser wools; the Weald was intermediate, between the two. A brief description of these areas makes the story more complete.

THE LOW WEALD is an area of impervious, heavy, clayey land, formed by the outcrop of the Weald Clay. The chief characteristic of the soils is their heaviness. The district is low lying and for the most part flat with impeded natural drainage. Most of the land is normally under grass, such arable as there is being cropped chiefly with wheat, oats, beans and mangels. Hall and Russell in their classic work on the soils of this region described this grassland as being " very poor in character, the herbage chiefly consisting

of various forms of Agrostis (bent), Crested Dogstail, Cocksfoot, Yorkshire Fog, with Rye-grass and rough Stalked Meadow Grass in the better patches."

ROMNEY MARSH is a plain of alluvium and marine detritus, and most of the region is a few feet below the high-water line. The superficial layer varies from shingle, covered only in patches by vegetation to a deep rich alluvial deposit, ranging in texture from sandy loam to clay loam. The best pastures rank among the finest in the country, some of them carrying and fattening twelve sheep to the acre during the grazing season, but on the other hand some of the grazing is only moderate in quality and some definitely poor. Shelter is scarce, the fields being divided by dykes instead of hedges, so that most of the land is exposed to the full force of the rain and wind in winter and to the unrelieved glare of the sun in summer. The area stretches along the coast from Hythe to the River Rother and inland to the Royal Military Canal, being, in all, over 40,000 acres in extent.

THE CHALK. This area is less clearly defined than the Low Weald or the Romney Marsh. It consists mainly of upland and hills up to a height of 500 feet and more above sea level. These hills or downs have a steep southern scarp face and a gradual northern dip slope. Cutting this region are deep valleys which usually run northwards and most of them are dry. On the top of the hills superficial deposits frequently cover the Chalk, they vary in depth from a few inches to as much as twenty feet and range in texture from sandy deposits to quite heavy clays, the latter usually containing flints. The sides of the dry valleys are covered by a very shallow soil and poor vegetation, much of which consists of pasture weeds, fine-leaved grasses and tor grass. At the bottom of the valleys is a deposit of soil of varying depth, which has been washed down from the hills; this deposit varies greatly in texture, but is usually a good soil, frequently a loam, growing pastures moderate to good in quality.

In addition to the variations caused by district the author found considerable differences between seasons, and these he assumed were caused by the differences in seasonal growth (lush to poor) of the grass. The amount of rainfall in the summer months is largely the governing factor. Figure 16 shows the grading of Kent greasy ewe wool during three seasons, the annual rainfall (June–May inclusive) being shown in brackets after the year. The wet year (1928) produced a lower proportion of the finer grades of wool and a higher proportion of the coarser grades of wool; the reverse applies in the drier years.

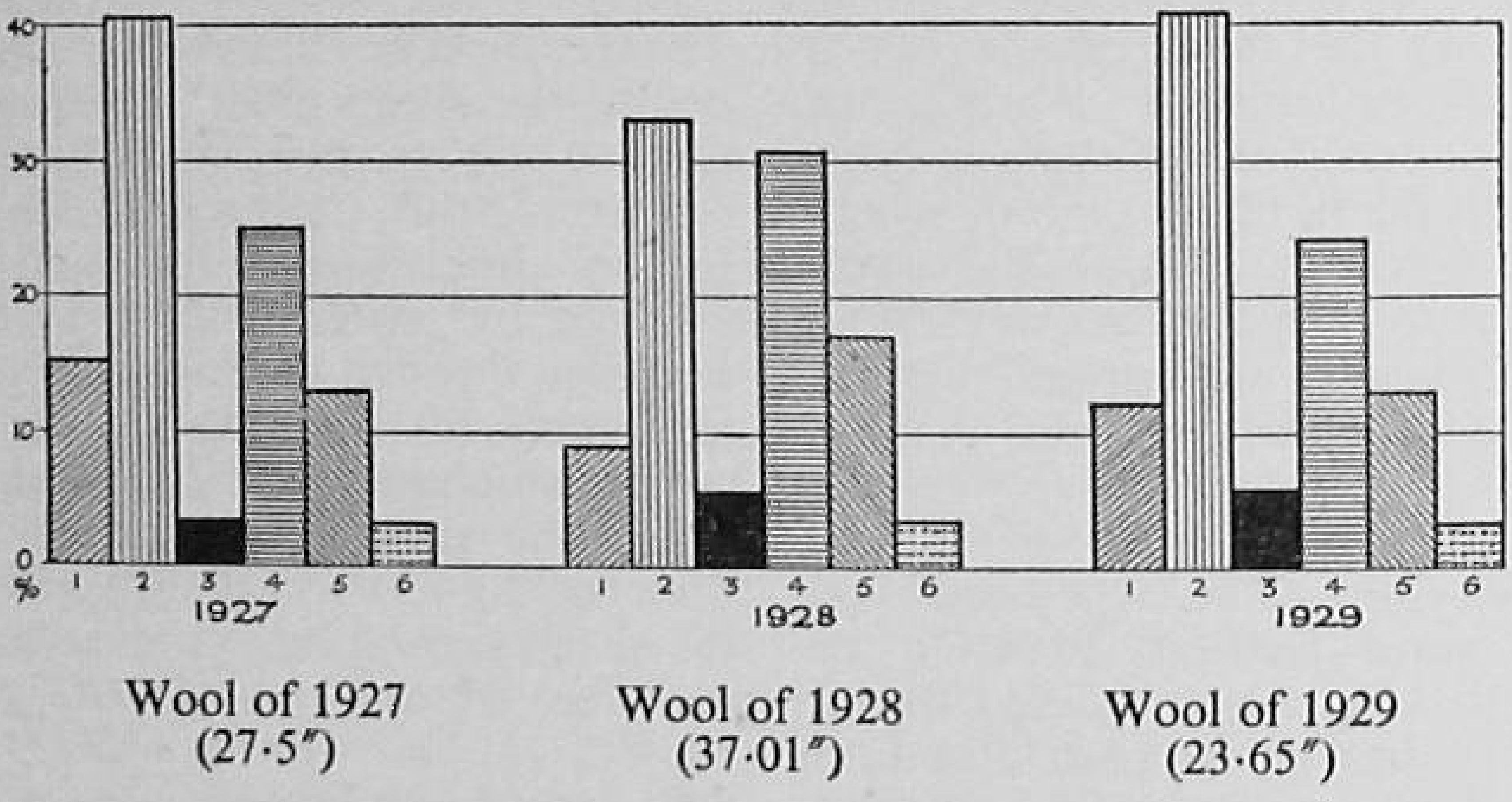


FIG. 16. The percentage of various grades of Kent Ewe Wool produced during the years 1927, 1928 and 1929. In this diagram Romney Marsh, the Weald and the Chalk Formation have been taken together. The numbers at the foot of the columns refer to the grades in Table 11.

SHEEP DISEASES AND AILMENTS

Here the author deals with signs of health and ill-health, health precautions and the diseases of the sheep. Methods of handling and dosing sheep are described.

Signs of Health and Ill-health.

ONE of the first signs of ill-health in a sheep is curiously enough a drooping of the ears. In the case of white-faced sheep this is usually accompanied by a dull, dirty appearance in the face. Most animals prefer solitude when they are feeling ill and the sheep is no exception, so that a sheep which keeps away from the rest of the flock should always be suspected. Restlessness when standing up and reluctance to get up when lying down are also signs that all is not well. Ill-health may also be indicated by the condition of the fleece, which gives indications like those seen in the hair of cattle and dogs and other animals when they show what is called a 'staring' coat; in the case of sheep the fleece appears rather open and rough instead of close and healthy looking. We must now discuss briefly a rather alarming number of sheep diseases, but fortunately, with good management and feeding, most of them are rare. Annual loss from death is usually about five per cent of the ewe flock, including those of the lambing season, in addition to which five per cent of the lambs born alive are likely to be lost later. Some lambs are born dead, particularly when there is very rough weather before the lambing time or where abortion is caused by dogs chasing the ewes. Foxes will kill lambs, and the carrion crow, hooded crow and raven will attack lambs, particularly those that are weak or sick.

Health Precautions.

The incidence of disease can be large controlled by clean grazing, good feeding, isolation of purchased sheep, isolation of sick sheep, efficient dipping, regular use of the foot-rot bath, attention to worms and conscientious and efficient shepherding.

Foot-Rot.

Lameness in sheep must be investigated at once; it is often due to thorns, stones, grit or dirt between the claws of the hoof. These things things can cause lameness by pressure alone or they may have been so long present as to cause a sore place, and this may even become septic. Treatment consists of cleansing the sore part thoroughly, applying some suitable antiseptic, preferably in paste form, and, if necessary, bandaging the foot. Before the war it was possible to buy Dunlop foot-rot boots with zip fasteners to keep the applied dressing on the foot and to prevent the entry of more dirt. A few of these boots may save loss of condition in lame sheep and effect a much more speedy cure than is possible with uncovered dressings or with bandages that easily come off.

Infectious foot-rot is a very different and much more serious matter. It is caused by a specific organism and is spread rapidly through a flock through contamination of the pasture by infected sheep. The most important thing to do on a clean farm is to prevent importation of the disease with purchased sheep.

In wet weather sheep should be grazed on the drier parts of the farm because the disease organism gains an easier entry when the horn of the hoof is soft. Once foot-rot has been diagnosed by lameness and an evil-smelling discharge beneath the horn of the foot, the infected sheep should be separated from the others. Infected sheep must have all loose, diseased and overgrown horn cut away from their feet with a sharp knife. A paste, made from a quart of warm Stockholm Tar, 2 oz. of bluestone (copper sulphate) and 1 tablespoonful of Lysol should be applied and covered with bandage or boot. As a precaution, when new sheep are bought they should be put through a foot-rot bath. The use of such a bath is a good routine measure on farms subject to foot-rot, and may be employed several times a year with advantage. The bath is a shallow trough 6 in. wide, 6 in. deep and about 10 in. long and is made of 1-in. boarding. Hurdles at the sides are used to keep the sheep in. The feet must be trimmed and cleaned thoroughly before the sheep enter the special bath and, in this, it is a great help if the sheep are passed through a 10-ft. bath containing clean water first. If this procedure is followed the sheep pass through the water bath, over a draining ramp and then through the foot-rot bath which is filled to a depth of 3 in. with a 5 per cent solution of copper sulphate (1 lb. dissolved in 2 gal. water). The sheep should pass through *slowly* to allow time for the feet to get well soaked. Afterwards the sheep should be left in a clean dry pen until their feet are dry.

Foot and Mouth Disease.

By law both affected and contact animals have to be slaughtered if an outbreak of this disease is confirmed amongst cattle, sheep or pigs. This course is drastic, but it designed to prevent the disease from spreading and becoming rife in this country. An outbreak must be notified to the authorities and the slaughtering and burning of the carcases then proceeds.

In sheep, lameness is the first symptom, followed by lesions in the mouth. Saliva runs from the mouth and the temperature rises. The spread of the disease and the occurrence of new outbreaks are very hard to explain and there is nothing that the individual farmer can do to protect himself from possible infection; all that can be done is laid down by law—slaughtering of stock and the imposition of a standstill order on livestock within a 15-mile radius of an outbreak

for about a fortnight and the order is generally cancelled after about three weeks if there are no further outbreaks.

Round Worms.

These are present in the stomach and small intestine of most sheep; when the number of worms present becomes excessive the sheep shows the characteristic symptoms. These are diarrhoea and a general loss of condition; the sheep looks less lively, there are signs of anaemia in pale eyelids and lips; the wool becomes harsh and dry. As a rule the animal's appetite is unimparred. If badly infected sheep are not treated they may die, but in any case the owner suffers financial loss from the check in growth and progress of those which survive. General treatment, beneficial to flocks in helping to keep them free from worms, consists in dosing all sheep brought on to the farm, and then avoiding overstocking, making changes of pasture as often as possible and preventing sheep on folds from running back again on to soiled ground.

The worms' eggs are passed out in the sheep droppings, hatch into larvae and are picked up by the grazing sheep; and, although there is no multiplication of worms inside the sheep, there is a rapid increase in infestation because the sheep pick up hundreds of fresh larvae. Even a one-year ley may quickly become heavily worm-infested if the sheep grazing on it are infested with worms at the outset. The larvae are resistant to weather conditions, but the most serious infestation is usually noticed from July onwards as the number of larvae on the pastures increases. This does not mean that worms are not prevalent before July, but merely that the infestation becomes progressively worse as the summer advances. Prevention therefore is all important and this can be achieved by using one of the various vermifuges, the newest of which is Phenothiazine. This substance not only removes the round worms from the sheep but also sterilizes the worms' eggs, and so prevents millions of eggs from becoming active larvae on the pasture. Phenothiazine has the additional advantage that the sheep need not be fasted before dosing; it has a disadvantage, however, in that it badly stains any wool with which it comes in contact. As a routine measure, four monthly doses may be given from the end of April onwards, lambs of 1–3 months old receiving one fluid ounce and sheep of over three months two fluid ounces. This should ensure that the worm infestation never reaches serious proportions.

Lung Worms.

These worms give rise to a condition called husk, lamb disease, parasitic bronchitis or lung worm. The small worm, present in the air passages, causes the husky cough so often heard amongst lambs in the autumn months. It is particularly prevalent on low-lying, damp pastures, especially when they are heavily stocked. The worm damage may eventually give rise to pneumonia and mortality may be high unless treatment is carried out. Stocking of suspected pastures should be avoided during the autumn and winter months. If infection occurs, injections of vermifuge into the wind pipe may be given.

Tape Worms.

The tape worm has a head which is firmly attached to the intestine of the sheep. The head gives rise to segments which are filled with thousands of eggs. The segments pass out in the sheep's droppings and the eggs are eventually eaten by a mite. The mites in turn are picked up with the herbage eaten by the sheep and so the larvae find their way into the sheep's intestine. Tape worms are not nearly so common or so destructive as round worms, but they are much more difficult to remove from the sheep; segments of the tape worm are often seen on the ground or in the sheep's droppings, but the head remains firmly attached to the wall of the intestine. Nicotine and copper sulphate mixture (see Appendix) is the most satisfactory vermifuge; phenothiazine does *not* deal with tape worms. The sheep should be penned after dosing so that the worm-infested dung can be destroyed or at all events not returned to the pasture.

Liver Fluke.

This disease, which is a very serious one to the flock-owner, is caused by a flat worm (*Distomum hepaticum*), reddish in colour, ¾ in. long and like a flat fish. It infests the bile ducts in the liver of the sheep. The eggs of this worm eventually pass out in the droppings of the sheep and, in dry, sandy places, perish. In damp, low-lying fields near stagnant water or ponds the embryo hatches out and finds its way inside the shell of a small water snail. After further development and multiplication the young fluke leaves the snail and attaches itself to grass, whence it reaches the stomach of the sheep and eventually reaches the bile ducts of the liver. There it proceeds to produce thousands of eggs and its life cycle begins again. In the early stages of infestation the liver is somewhat stimulated and the animals actually improve in condition. This temporary state of affairs is rapidly followed by decline in condition with noticeable anaemia (with pale eyelids and lips), followed by weakness, loss of appetite and loosening of the wool. Swellings usually appear under the jawbone and the animal becomes razor-backed and pot-bellied. Death is frequent and a post-portem examination reveals numbers of flukes in the liver. The disease is usually prevalent in the autumn and winter, particularly after a wet May and wet August and the eggs can, unfortunately, survive for a year. The prevention of the disease consists in keeping the sheep off low-lying ground in autumn and early winter or, if this is not possible, draining the land concerned.

Snails can be removed by dressing the land with 100 lbs. of a mixture of one part copper sulphate and four parts sand per acre; afterwards the stock should be removed from the ground until after rain. Should the disease be suspected, the sheep should be drenched with carbon tetrachloride or hexachlorethan (in its experimental stage still but less toxic) at the end of October, end of November and end of December; the time when the ram is serving the ewes should be avoided, if possible. It should be noted that phenothiazine is *not* effective against this parasite.

Anthrax.

This is a notifiable disease, that is to say it must be notified, by law, to the authorities immediately. It is fortunately now rare in this country; it affects most animals and also man. Cases of sudden death, due to unknown causes, should be reported; and the carcase should be left for examination and railed off from stock in the fields. Full details are given in the leaflets of the Ministry of Agriculture on this subject.

Fly.

The expression 'struck with the fly' means that either 'greenbottles' or 'bluebottles' have laid their eggs in soiled portions of the fleece, usually in the hindquarters, where diarrhoea has soiled the wool or along the back where birds have soiled the wool with their droppings. Green or bluebottle flies can be treated as one, since their effects are alike or if no treatment is carried out a dreadful death may result from the depredations of the maggots hatching from the fly's eggs. The female fly lays some 500 eggs, which hatch in about twenty-four hours into legless maggots; these first feed externally on the soiled wool and later eat their way into the flesh of the sheep. They become fully grown in fourteen days. The fly is most likely to attack the sheep in moist, warm, muggy weather from May until October, because moisture in the wool is necessary for the maggots' development. The fly may take as long as an hour in selecting the place to lay and actually laying the eggs. The best means of prevention are to keep the sheep free from diarrhoea, to trim the hind-quarters and to keep them clean, to bury any carcases or rubbish which encourage flies, dip the sheep thoroughly with a sulphur dip (which gives brief immunity from fly) or in the D.D.T. Gammexane dip which gives immunity for some six weeks. This dip is so effective that even in areas where double-dipping is the 'law' only one dip need be given. Should the sheep be struck with fly the symptoms are matting and dampness of the wool fibres, restlessness and wagging of the tail, rubbing against posts or biting at the infested parts, discolouration of the wool which falls out, oozing sores where the maggots are working and, of course, loss of condition. A good shepherd will recognize the symptoms of fly at once and the whole problem is one of the shepherd's chief headaches throughout the summer. If a sheep gets 'struck' by fly the wool around the infected part should be trimmed off and dressed with disinfectant or other preparation (see Appendix), the maggots should be picked off and destroyed.

Ticks.

These are found chiefly on rough, scrubby grazing. Eggs can live through the winter and consequently sheep may be re-infested each year. They cause trouble, not only because of loss of condition due to the irritation of the bite, but also through the spread of blood-borne diseases such as Louping Ill. The larvae of the tick fall from the sheep to the ground, change into what is known as the nymph, a stage in which they find their way onto another sheep upon which they feed; they afterwards fall to the ground and change into the adult tick; this also finds its way onto a sheep, feeds, falls to the ground, lays eggs and then dies. The eggs hatch into larvae which find their way onto a sheep so that the life-cycle begins anew. The larvae, nymphs and adult ticks are all capable of carrying disease from an infected sheep to a healthy one. Dipping kills those ticks which are on the sheep, but it does nothing to remove the pests from an infected pasture, and so this pasture must be rested for at least a year if it is to be cleared. Sheep should always be dipped on leaving an infested pasture to go onto a clean one. The percentage losses amongst sheep in tick infested areas (there are 800 square miles of it in North England) is much higher than in clear areas (1941 W. Lyle Stewart).

Keds or Fags.

These unpleasant-looking insects are wingless flies, being reddish brown in colour, with a thorax (bearing six legs) and a large abdomen. Their bites cause irritation and loss of condition and each sheep may carry many keds. Efficient dipping kills the keds (but not the pupae) and this is especially important because autumn dipping clears the fleece of keds before the winter and prevents possible loss from sheep getting stuck on their backs whilst trying to relieve the irritation. The parasites present are effectively killed by the D.D.T. Gammexane dip, and so are the newly emerged keds for some weeks after dipping.

Louping Ill.

Occurs principally in Scottish and English uplands amongst hill sheep. The minute organsim which causes the disease is tick-borne and on entry into the blood stream is carried to the nervous system where it causes paralysis and eventually death. The disease starts with a high temperature, and there are symptoms of twitching and trembling before the stage of paralysis is reached. Vaccination of adult sheep is satisfactory but is not without danger when given to lambs.

Hoven or Bloat.

Occurs when sheep are given access to luscious keep after being on a lower standard of nutrition. It is most likely to occur where clover or lucerne is abundant. Before sheep are turned on to such pasture they should be allowed to fill their stomachs as much as possible and should even then be allowed on the lush field for only a short time; they should then be returned to their scanty fare before having a rather longer spell on the luxurious pasture, and so on until they are accustomed to the new conditions. If sheep become ' blown ' the medicine recommended in the Appendix may be tried but the use of a trochar and cannuala is the most likely treatment to succeed. The trochar and cannula consists of a sharp pointed blade with a sleeve around it; both are pushed into the rumen, or first stomach, the trochar (the knife part) is then with drawn and the gases rush out through the sleeve.

Wool Balls.

These cause some deaths in lambs and are accumulations of wool fibres taken from around the ewe's udder, mixed with any wool picked up from the ground together with some plant fibres. The constant movement of the rumen converts these fibres into masses which are generally globular in shape; they have the consistency of felt. The ball will eventually cause a stoppage, probably at the pyloric orifice (the exit from the fourth stomach).

Mastitis

This is an inflammatory disease of the udder and is alternatively known as Garget. Suckling ewes affected with this disease may lose their appetite and show a slight rise in temperature. The affected half of the udder is hot, painful and inflamed; the secretion from the udder is of unusual appearance and hard patches may be found in the affected part. Hot poultices should be applied to the udder and the ewe should be dosed with Epsom Salts. The secretion should be drawn from the udder and the trouble may then clear up.

Navel Ill or Joint Ill.

This disease attacks newly born lambs, the pus producing bacteria entering the body through the navel. The lamb moves stiffly and loses its appetite; later, the joints swell and abscesses form in them and afterwards via the blood by circulation through the blood stream the bacteria reach liver, lungs or kidneys and form abscesses there. There is no cure but prevention depends on choosing clean ground for lambing, avoiding the old-fashioned permanent lambing pen, dressing the navel of the lamb with such an antiseptic as iodised phenol or iodine, the navel cord being thoroughly soaked.

Braxy.

Occurs principally on the West Coast in hilly districts, between the months of September and, January. Death occurs in a few hours after the animal is taken ill, but during those few hours it may be noticed moving in a jerky manner. The body becomes blown up with gas and actually starts to putrefy before death; this peculiarity of the disease formerly caused much trouble to research workers in obtaining fresh material for their investigations. The carcases should be buried, the remaining sheep moved to a fresh pasture and given a preventive vaccine.

Sheep Scab.

This was at one time the cause of very heavy losses amongst sheep in these islands. It is caused by a mite which, burrowing into the skin, causes acute irritation. As a result there is loss of condition, raggedness of the wool and considerable financial depreciation. By law, all sheep must be dipped once a year and in some parts of the country twice during the year. The reason that this policy has not completely eliminated the disease is that in hill and mountain areas it is almost impossible to round up every sheep for dipping. The disease reaches non-infected sheep through their rubbing on posts previously used by infected sheep. Efficient dipping kills the mites but not the eggs, so that (in double-dipping areas) after seven days have elapsed for the eggs to hatch a second dipping must be carried out. Not longer than fourteen days must be allowed to pass before this is done or the newly hatched mites will have reached maturity and will themselves have laid eggs. Details of the dipping operation will be found under the heading " THE SHEEP YEAR," pp. 591–598.

Pulpy Kidney.

This attacks lambs between the ages of 3–8 weeks, but occasionally outside these limits. Unfortunately, it is usually the most thriving lambs that become affected and they are found dead for no apparent reason. Examination immediately after death shows congestion of the kidneys and after an hour or two they are soft and filled with a jelly-like mass. There is now a serum available, with which lambs can be injected as a prevention of the disease; it gives satisfactory results. This treatment is only carried out on farms where the annual loss is heavy; it should be borne in mind that a great many losses hitherto attributed to ' wool balls ' are now known to be caused by pulpy kidney.

Struck.

This disease occurs in different parts of the country and exhibits in older sheep symptoms like those of pulpy kidney disease in lambs. Death is sudden and putrefaction, which sets in almost before death, is due to absorbed toxins, caused by a bacterium. This disease is of comparatively

local importance and is preventable, where circumstances warrant the expense, by the use of vaccines. Death is too rapid for any curative treatment. Carcases should be buried intact in lime.

Sturdy or Gid.

Not so serious as it used to be because its cause is known and therefore the life cycle of the parasite which causes the disease is more easily broken. The parasite (the larva of a tape worm) which forms cysts on the brain of the sheep must after development find its next host—a dog. Therefore the heads of dead sheep must not be fed to dogs under any circumstances. Whilst the larva is in the cyst on the brain it causes pressure, which makes the sheep walk with a staggered gait and often to gyrate. It may result in death, and in any case cause loss of condition in the affected sheep, which, it is found, are most commonly yearlings. The only cure is an expensive operation; the prevention is to break the life cycle of the tape worm by preventing infection of dogs.

Lamb Dysentery.

This is quite distinct from scour or diarrhoea in any ordinary form, because it is a specific infection of the intestines of young lambs under ten days old. The infection can be carried over from one year to another, and if nothing is done it becomes progressively worse year by year. Infection was found to occur so soon in life that a mistaken idea formerly arose that the lamb was infected before birth. In actual fact the bacteria are picked up from the soil either from the udder of the ewe or from particles of soil adhering to the lamb's wet body. Death is rapid, though symptoms such as stiffness and bleating with pain may occur; there is general dullness and finally diarrhoea, generally of a yellow or whitish hue, occurs. Satisfactory inoculations with serum are available for use on infected farms; the serum should be used within twelve hours of birth. Alternatively, the ewe can be vaccinated twice (in autumn and again ten days before lambing); this immunizes the lamb through the ewes colostrum; this is not so certain as inoculation of the lamb, but is simpler on hill pastures where it is easier to deal with the ewes before lambing begins.

Handling Sheep.

In the author's opinion, the sheep is the only farm animal which can be handled with complete control and satisfaction. But the correct methods must be mastered, because those who do not known them will quickly become worn out. A mechanical advantage over the sheep is essential.

Methods of Catching and Holding a Sheep. There are two holds by which a sheep can be controlled. Firstly, by gripping the wool on the underside of the neck (the throat), and the other is by the wool or loose fold of skin in the groin. By the first method the sheep can easily be held, but it is difficult to pull the sheep along with this grip; by the second method one hind leg can easily be raised from the ground and the sheep can be drawn tail foremost in any direction. Care should be taken if the sheep is held by the wool on the hind leg that the wool is not twisted or pulled too hard; the author has seen a huge piece of skin pulled right off by this method. If the sheep is to be held for some time one hand should be used to hold the sheep under the neck, the sheep is held against the knees and the other hand should be placed over the sheep's loins to grip the wool in the groin. Sheep should not be caught by a hind leg below the hock, as it is possible in this way to twist or break a leg. Catching a sheep by the wool along the flanks gives the catcher no mechanical advantage and the sheep with all four feet on the ground will probably prove the stronger.

Methods of Throwing a Sheep. (1) Stand with the knees against the flank of the sheep. Bend the head round on the side farthest away from you. Move backwards so that as the sheep overbalances it falls over the ground more or less on the spot where you were originally standing. (2) Place one hand underneath the sheep and grip the further hind leg. Pull this leg towards you under the sheep, pushing the animal away from you so that it falls to the ground. (3) Stand with the sheep's flank against your knees. Grip the sheep's flank on the far side fairly low down. Lean backwards, pulling upwards with your hands. The sheep's four feet will be levered off the ground and it can then be laid down at your feet. This method is not so practicable with very large sheep.

Methods of Weighing Sheep. It is not normally necessary to weigh ewes, but lambs before sale are often weighed, as also are tegs during the winter. Two hurdles or a tripod should be erected so that a spring balance can be hung from the top of the structure so formed, the apex in the case of the tripod. A strong canvas sling is made and it is provided with strong leather handles. The sling is put round the belly of the sheep and the two handles are then placed over the hook of the spring balance, the weight of the sheep being gradually released until the animal is hanging in its sling. The weight should be read as quickly as possible whilst the sheep is lying still. This method is perfectly sound, though rather hard work, because the sheep, weighing perhaps over 100 lb., must be lifted some distance from the ground. It is as well if one man lifts the head end of the sheep, holding the handles of the sling also, whilst another man lifts the animal's hinder end.

Handling for Dipping. The sheep are assembled in a collecting pen and have to be slid tail first into the dip bath. Each animal is pulled

to the edge of the bath, the left arm is placed round under the neck, whilst the right hand grips the wool near the far side groin. The sheep can then be lifted head uppermost and seated on its rump on the edge of the bath and slid into the dip.

HANDLING FOR CASTRATION. The lamb should be held with its back against the holder's abdomen or chest and a fore and hind leg gripped in each hand.

HANDLING OF SMALL LAMBS. These can be caught round the neck, with a crook or a stick with a curved handle, and pulled towards the catcher. A small lamb can be carried by the forelegs in one hand, but it is better for the lamb if it is carried in the crook of the arms against the chest.

HANDLING FOR DOSING. Medicines may be given in the forms of liquids, capsules or injections. The giving of *injections* requires no comment, the hypodermic needle merely being inserted under the loose skin of the neck and the required quantity of liquid squeezed in. The administration of a *liquid* dose may be done either with the sheep sitting on its haunches or standing up with its rump against a hurdle to prevent its backing away. In either case the head must be held at its natural angle and should not be tipped back; the tipping back of the head makes the sheep more liable to take the dose into its windpipe instead of into its gullet. Bottles and funnels for the giving of medicines in liquid form can be purchased, but the most convenient method is the syringe, which may be of a sufficient size to hold a dose for several animals. Attached to the syringe is 8 or 9 in. of stout rubber tubing; the tubing is inserted to the back of the mouth and the required quantity squeezed in. Syringes which will hold sufficient for several sheep are obtainable, but they only release, each time they are used, the quantity of liquid required for one sheep. With the majority of drugs it is advisable to fast the sheep overnight before dosing and to retain the animals in their pen for a little while after dosing; do not dose hot, breathless sheep which have just been driven and do not drive sheep immediately after dosing.

Capsules must be held with two fingers and be placed at the back of the mouth, the mouth being held open with the other hand. The mouth is then closed and held shut until the capsule is swallowed. This method is rather difficult because slippery saliva on the fingers makes the holding of the capsule difficult. This complication can be overcome by putting the capsule in the mouth of a small glass bottle containing some water. As the bottle is tippled up the capsule is washed out of the bottle neck and down the sheep's throat.

THE FEEDING OF SHEEP

The digestion of the sheep and the difficulties of rationing foods to sheep are briefly explained. An outline is given of the feeding of Grassland, Arable and fattening flocks.

The sheep is a ruminant; its stomach has four compartments. The largest of these is the rumen or paunch into which the practically unchewed food passes from the mouth. Later this food is regurgitated into the mouth in small wads to be properly chewed, the process usually taking place whilst the sheep is lying down. It is the fourth compartment that is the equivalent of the human stomach and it supplies the digestive juices. From the point of view of practical feeding the significance of this system of digestion is that the very large capacity of the paunch enables the ruminants to deal with much bulkier foods than non-ruminants such as the pig. Sheep normally obtain $\frac{6}{7}$ of their total food requirements from pastures, roots, hay or other bulky foods, leaving only $\frac{1}{7}$ to be supplied by concentrated foods, which in these post-war days are so difficult to obtain. By comparison, cattle require $\frac{1}{6}$ as concentrates and pigs $\frac{9}{10}$ as concentrates.

The accurate rationing of sheep is more difficult than that of cattle or pigs for two reasons. Firstly, because sheep obtain the bulk of their food from pasture or from root crops on arable land; in either case the sheep with the largest appetites and the most truculent dispositions obtain more than their share, whilst the shy and weak sheep obtain less. This difficulty is also found when mangels are carted out to in-lamb ewes on grassland; the writer knows of lambs being born dead as a result of the ewe being a mangel glutton. Secondly, the concentrated foods, where these are fed, are placed in troughs to which all the sheep have access at the same time, with the obvious result that again the stronger and greedier sheep get more than their share of food.

The quantity of grass consumed can be controlled as far as the flock, but not the individual sheep, is concerned, by increasing or decreasing the number of stock running on any given area. The more the growth of grasses and clovers is controlled, the better the feeding value and the more food will be obtained from a given area, conversely it is uneconomical to allow grasses and clovers to grow away from the sheep, so that coarse tufty herbage of poor feeding value is left. Herbage of this coarser kind can be grazed off by cattle, so that the area covered by tufts is brought back into even grazing. As the cattle eat the longer herbage they destroy very large numbers of sheep parasites, the larvae of which are present in large numbers on the longer grass. Mixed grazing with cattle and sheep is therefore of mutual benefit to both forms of stock. The ideal treatment is rotational grazing so that all herbage is grazed off in a few days by a heavy stocking of sheep or cattle which are then moved on to a fresh area. This is not very practical with sheep owing to fencing difficulties; it should be borne in mind that the sheep is insulated against shock from electric fences by its wool, so that although these fences are quite adequate for cattle and pigs they are useless for sheep.

Folding crops such as turnips, swedes, kale, sugar-beet tops, rape and mustard can be controlled by the area of fold which is set for the sheep every day or every other day. It is quite a simple matter to calculate the area required for one sheep a day to supply a given ration. A crop of 22 tons per acre represents 10 lb. per square yard, so that a 10-lb. or 20-lb. ration represents 1 or 2 square yards per sheep per day.

Concentrated foods are easily rationed. They are usually weighed out once a week for each lot of sheep and are then carted round and stored in a locked bin in the field. The shepherd on his daily round takes out the daily ration from the bin.

Outline of the Feeding of a Flock of Grassland Ewes and Lambs.

After the lambs have been weaned, the feeding of the ewes for the following crop of lambs begins, and this time may be taken as a convenient starting place for the year's feeding. If the lambs are removed from the ewes about 1st August, all the ewes should be run on poor grass in order to dry up their remaining milk. It may well be that there is little grass at this season if the summer has been a hot one. All extra food such as concentrates is cut out and the ewes are often formed into large flocks so as to reduce the number of fields the shepherd has to visit each day. If we assume that the ewes are to be mated again in mid-October they will have to be sorted into flocks about 1st September, before being brought into gradually improving condition. Improvement in condition is best obtained by running the ewes over stubbles that have been under-sown with trefoil or ryegrass, or by putting them on to the aftermath of hay fields or by running them on mustard, rape or white turnips grown after an early harvested crop such as canning peas or silage. They will usually be mated on grassland in mid-October, and it should be noted here that the rams should also be brought to mating in good condition but not fat. Rams frequently feed badly when running with the ewes and should therefore be given the best possible start.

In normal autumn there should be plenty of grass for the ewes throughout October and November and no additional feeding should be necessary. The calls of the lamb are small at this stage of pregnancy so that no extra feeding is required; moreover, it is undesirable to get the ewes in too fat condition at this period. It is relevant to include here a reference to the invaluable work of Hammond and Wallace at

Cambridge. They found that better lambing results were obtained where the plane of nutrition was on a high level during the last six weeks of the gestation period; ewes so fed gave better results than ewes which were on a high plane of nutrition throughout or on a low plane throughout or started on a high plane and finished on a low plane. Ewes which only finish on a high plane are not so fat as those which are on a high plane throughout, yet their good feeding during the last six weeks of the gestation period has the same effect on their milk supply as 'steaming up' a cow before calving. The lambs get a much better start and results altogether are more satisfactory. The first part of this policy, the low plane of nutrition, will occur during October, November, December and January. It has already been pointed out that grass alone should suffice. In some cases it may be impossible to do otherwise (for example in mountain areas where the carting of such food is impracticable) but the results will show in the lamb average. In these post-war days priority is given to dairy herds and the ewe flock often has to put up with rations which are not required by the cows, and their grazing is often the 'leavings' of the cows. With the priority which is given to milk production at the present time and the profit which can be made from a well run dairy herd, this is undoubtedly the right policy.

Materials which have come into common use as a bulk food for ewes and which also help to economize in the concentrated foods are (1) clover pug, the chaff resulting from the threshing of clover seed or clover and grass seed, (2) linseed chaff, the result of threshing linseed, (3) the 'hay' resulting from the threshing of clover or clover and grass seed mixtures. These materials are usually of low feeding value because the main food value of the plant has been absorbed into the seed, but they do serve as a fill-belly and will effect some economy in concentrates. The writer has encountered some clover pug of high feeding value (up to 15 per cent crude protein) collected from a seed crop of wild white clover and ryegrass which had been harvested on tripods; in these samples there was still a large proportion of the clover leaf.

About the middle of May the feeding of concentrates to the ewes may be discontinued, but this decision, like all feeding decisions, must be determined by circumstances. Obviously, it is not possible to lay down hard and fast rations for the ewes, but Table 12 attempts to summarize what has already been said.

Ewes produce an average of about three gallons of milk per head weekly, and this forms the most important part of the lambs' diet for the first two or three months of their life, and lambs still obtain some milk from their mothers at four months old when they are usually weaned. At four months the lambs, with their wool on, look almost as large as their mothers, which have

TABLE 12

DIARY OF FEEDING OF GRASS FLOCK

(mated mid-October)

Ration in lb. per head per day

	Grass	*Mangels*	*Concentrates*	*Hay*
October	Should be plentiful	—	—	—
November	Some	—	—	—
December	Very little	—	$\frac{1}{4}$	If snow
January	,, ,,	8	$\frac{1}{2}$–$\frac{3}{4}$	,, ,,
February	,, ,,	8	$\frac{3}{4}$–1	,, ,,
March	Some	8	$1\frac{1}{2}$	,, ,,
April	Should be plentiful	8	1–$1\frac{1}{2}$	,, ,,
May	Should be plentiful		Cease mid-May	—

been shorn. At about ten days old the lambs begin to eat; they begin by nibbling at the finest grass leaves, but quite soon the lambs will begin to eat a little of the ewes' trough food. It should be clearly understood that fat lamb of high quality can be produced from the ewe's milk and the grazing of a good ley without the addition of any concentrated food. Nevertheless many flockmasters consider that trough food given to the lambs shows a return when the lambs are sold. Records at Wye show that lambs which are given trough food *ad lib* for the first four months of their life until they are sold will consume about 56 lb. of concentrates, which before the war probably about 8/– per cwt.; the post-war price raises very grave doubts as to the desirability of giving trough food to lambs.

The management of the grassland during this period is all important and the old adage "the worst enemy of a sheep is another sheep" is only too true. The underlying principle if the sheep are to remain on one field, should be to keep the rate of sheep stocking as low as possible to avoid excessive worm infestation of the pasture and to use cattle for eating the surplus feed. Rates of stocking must obviously vary if the grassland is to be kept under control because the rate of growth at different times of the year varies. In May and June, for example, growth is at its maximum and more sheep will be required to graze it properly; this additional number of sheep often comes from a field which is going to be mown for hay or for seed production.

There are several common methods of grassland management. (1) Each field has a more or less permanent stock of sheep all the year round, additional sheep or cattle being drafted in during periods of heavy growth. (2) Half the pastures are grazed by sheep and the other half are rested from sheep. (3) A large number of stock is moved round the farm, grazing each field in turn. This method reduces the chance of heavy worm infestation, because the animals are not grazing for long periods on pastures infected with sheep droppings.

Outline of the Feeding of an Arable Flock of Ewes and Lambs.

The most suitable soils for arable sheep are light in character and with good drainage, so that they remain relatively dry during the winter months; heavy soils are unsuitable. On soils of light character swedes, turnips, thousand-headed kale, marrow stem kale, mustard, rape and mixtures of rape and turnips are grown for the purpose of feeding the flock. The growing of 400,000 acres of sugar-beet in this country produces a lot of sheep food in the form of tops and crowns (the top part of the root from which the leaves grow) and mixtures of grasses, clovers and sainfoin are specially grown for grazing purposes. Cereal crops such as winter rye, winter barley and winter oats are also sometimes sown for early spring grazing after the crops just mentioned are finished.

The usual method of feeding the crops is to fence off a portion of suitable size with hurdles or wire netting. When the crop growing inside this fence has been eaten the sheep are allowed on to a fresh ' fold '. It is considered unwise to allow the sheep to run back on to the old folds because they are more likely to pick up worm infestation by so doing. After lambing, the lambs are allowed on to the fresh folds ahead of the ewes. This is done by means of ' creeps ', which have openings sufficiently large to allow the lambs to pass through, but too small to allow the ewes to enter.

This system of folding increases the fertility of the land, because of the sheep manure, which contains the residues of the hay and concentrated foods in addition to the residues of the crop on which the sheep are folded. The same building up of fertility takes place on the clover and grass mixtures on which the sheep are folded.

The sequence in which these folding crops are grown and used differs from farm to farm, but a general outline will be given. During the months of May, June, July, August and September, the flock will be grazing on a ley consisting of a mixture of whatever grasses and clovers are suitable for the particular district and climate concerned. During the latter part of September or possibly early in October the flock will move on to rape and turnip mixtures, mustard or turnips; changes of feed must always be made gradually and it is usual to throw a few turnips on to the grazing land to accustom the sheep to them before moving them on to the fold. This feeding will continue until the end of the year, with the possible addition of marrow stem kale to the selection of crops. After the new year, thousand-headed kale and swedes form the bulk of the diet until the flock is moved on to cereals for use during March and April.

On farms where sugar-beet is grown the flock may be folded on the tops and crowns throughout the sugar-beet lifting season, which extends from October until some time in December, depending on the acreage to be dealt with and the amount of interference from the weather.

The nutriment obtained from these crops may be looked upon as the maintenance ration. It is not advisable to rely entirely on the folding crops for this purpose and a small daily ration of hay has an advantage to the ewes far in advance of its actual feeding value. During the last six weeks of the gestation period a supplementary ration of concentrated food should be fed, using the same quantities per head per day as in grass flocks.

It is unnecessary here to go into a full explanation of the composition of foods and the method of calculating sheep rations. *The Principles and Practice of Feeding Farm Animals* (Halnan and Garner, 1946) fully explains the modern conception of stock feeding, and it is only necessary here to say that a ewe giving 3 gallons of milk per week requires between 27 and 30 lb. of Dry Matter in her food weekly, 20 lb. of Starch Equivalent, and 3·6 lb. of Protein Equivalent weekly, which is supplied by the following daily ration:

20 lb. swedes.
½ lb. clover hay.
1¾ lb. of a mixture of 4 lb. beans, 2 lb. linseed cake, 2 lb. flaked maize, 2 lb. decorticated groundnut cake, 2 lb. crushed oats.

During wet weather it is advisable to allow the flock to lie on grassland at night if there is a suitable field near at hand; this is drier and more comfortable for ewes.

Outline of the Feeding of Fattening Sheep.

Many lambs are sold at the present time as fat lamb at weaning or from grass and stubble feeding during the autumn months. If, however, the lambs are to be fattened during the winter, it is necessary to grow crops on which they can be folded. The method of folding is the same as that described for the ewe flock. Halnan and Garner state that 109 lb. lambs expected to gain 2½ lb. in live weight per week would require just under 20 lb. Dry Matter per week, just under 12 lb. Starch Equivalent and 1·78 lb. Protein Equivalent. These constituents would be supplied by the following daily ration:

14 lb. swedes.
⅛ lb. hay.
1 lb. of a mixture of equal parts of undecorticated cotton cake and dried brewers' grains.

LABOUR, CAPITAL AND RETURNS

Importance of skilled labour. Cost of labour. Capital required to establish a flock of sheep. Cost of keeping sheep. Probable returns.

Skilled Labour.

THE Shepherd has a somewhat lonely job, necessitating visits to the sheep in all weathers (often when the other men on the farm are working under cover). If he is a full-time shepherd, the only time when he works with other men is at dipping, possibly at shearing time or when sheep are being dosed or weighed. If his flock is not large enough to occupy him full-time, he employs the remainder of his time on other work. His work cannot be mechanized, nor can it be satisfactorily carried out by a series of short cuts; it must be done conscientiously and efficiently if the balance of the sheep account at the end of the year is to be satisfactory. For these reasons the modern young man does not take kindly to shepherding, and lack of adequate labour to look after the sheep may well be the limiting factor in any future expansion of the sheep population. The good thing about the shepherd's work is the constant interest throughout the year as the various operations so fully described under the heading, " THE SHEEP YEAR " pp. 591–598, are carried out.

Cost of Labour.

The shepherd's pay in autumn 1948 was 90/– for a 48-hour week, with 2s. 4d. per hour for overtime on weekdays and 2s. 10. per hour for overtime on Saturday afternoon, Sundays or Bank Holidays. The shepherd's house and garden cost him 6/– per week, of which the majority can be regained in garden produce and poultry products. He buys his milk for 3d. per pint and his potatoes, coal, wood and garden manure at the wholesale prices prevailing in his district, so that his basic wage of 90/– is misleadingly low when it is compared with that of the town worker, who has an expensive house, no garden, probably no opportunity of working overtime and at the same time has to pay full retail price for the commodities just mentioned. Rabbits, hares, mushrooms, blackberries and pigeons are all likely to appear on the shepherd's table, though it is surprising the number of country workers who will not eat some of these items of food. The shepherd has six days holiday each year with pay in addition to the Bank Holidays.

The efficiency and conscientiousness of the shepherd are in large measure responsible for the results obtained in the year's work. As an example of this, the Wye College farms during the years 1930–44 mated 4,184 Half-Bred ewes and tailed 151·6 lambs for every 100 ewes put to the ram and actually sold 149 lambs for every 100 ewes put to the ram. This is a record of which any shepherd has a right to be proud and one which the vast majority of farmers must envy. Careless shepherding could easily have reduced the above figures to about 130 lambs per 100 ewes. A shepherd is almost fully employed on sheep where 400 ewes are kept on grass. Occasionally he may have time to spend on other branches of the farm, particularly after the ewes have been weaned and if the lambs are sold in July he will be able to assist with harvest. Conversely, at certain times of the year the shepherd must have some help; as examples of this may be mentioned, mangel carting to ewes on grass during lambing time and hay carting to ewes during snowy weather, several men to help with dipping and one man to help with dosing, tailing and castrating. On arable and mixed farms, where the ewes are folded for all or part of the year, 250–350 ewes will keep the shepherd occupied. On farms where only a few sheep are kept as scavengers their care will be the part-time responsibility of one of the men on the farm.

Capital Required to Start Sheep Farming.

No book on sheep farming would be complete without some estimate of the amount of capital required to start such a venture, but few tasks could be more difficult. Firstly, it must be realized that there are few purely sheep farmers except in mountain areas. The vast majority of farms on which sheep are run keep the sheep as part of a mixed farm, with the results that it is virtually impossible to say how much of the fencing materials, troughs, food bins, etc., could fairly be charged to the sheep and how much of the general costs of hedging and ditching, and how much of it should be shared by the cattle or charged against the protection of crops. Each case must be assessed on its own merits. The chief items of capital expenditure are the purchase price of the ewe flock, the purchase price of the rams and sufficient money to pay wages for perhaps nearly a year from autumn until the lambs are sold and to purchase food and sundries for the flock. These can be summarized as follows:

The purchase price of ewes depends, of course, on the age of the ewes and the current market prices. Young ewes or gimmers at maximum prices may cost £10 each for non-pedigree breeding ewes; when prices are low they may be bought for about 50/–. The capital invested in the sheep themselves may therefore easily be assessed by multiplying the current market price by the number of the ewes concerned. If a flock of mixed ages is to be purchased then of course the average price per head will be lower because the older ewes cost proportionately less. Once the flock is established it is probably wisest to value it from year to year at current prices. This may, of course, show a profit which has not actually been realized, since the ewes have not been sold and similarly it may show a loss. An

alternative method is to allow a fixed figure per head for the various classes of ewe; this cannot at present be considered satisfactory since the 1939 values for a ewe flock would hardly look reasonable in the books in 1948. A further method is to assign a life to the ewe when purchased and to depreciate her annually by her purchase price minus her final selling price divided by the estimated number of years of her life. Thus a ewe purchased for £6, which is likely to sell for £2 after breeding four crops of lambs would depreciate at the rate of 20/– each year. The obvious weakness of this method is that during eccentric years an old ewe may sell for almost as much as her original purchase price should the value of sheep happen to rise greatly during her breeding life. It is impossible, particularly at the present time, to make any adequate forecast of value several years ahead. The valuations of the ewe flock at the beginning and end of the year, plus any purchases and minus any deaths and sales are entered on the appropriate sides of the 'Stock Account' and at the end of the year the balance is transferred to the 'Trading or Revenue Account' and represents the depreciation of the ewes. The cost of labour can reasonably be estimated for a year, though inaccuracies would inevitably have occurred during the last few years, owing to the rapid rise in the rate of wages. This task is much simpler on farms where the shepherd is employed almost entirely with the sheep and is more difficult where only a small flock is kept and the shepherd therefore has only to spend part of his time with it. During normal times the quantities of food necessary for a ewe for a year and for her lambs for a year are easy to estimate; at present the animals only receive what can be spared for them. Normally, a grass ewe on a high level of nutrition receives concentrates from early January until lambing time in March and for the first few weeks that she is suckling her lamb. In May the feeding of concentrates to ewes ceases. On some farms at this time the concentrates are transferred to the lamb. Ewes so fed will eat about 1 cwt. of concentrates per year. The lambs from the time they receive concentrates in May until they are sold on, say, 1st August, will eat about ½ cwt. per head.

The cost of grazing is easy to assess and consists of the rent of grazing fields, a share of the rent of mowing fields, manual, horse and tractor labour, artificial manures, lime, shares of the hedging and ditching costs, and also of the general farm overheads, such as office expenses, and insurance policies. The difficulty arises when this total cost has to be divided amongst the grazing stock. If a cow is taken as a unit of grazing then a ewe may be taken as 1/7th of a unit, a yearling sheep as 1/10th of a unit and a lamb from 1/20th at a few weeks old up to about 1/12th at weaning. The number of units of grazing obtained from all the pasture can thus be worked out and the cost per unit obtained. The proportion to be charged to the sheep, cattle and so on can then be calculated. In practice the cost accountant does not use this somewhat laborious method, since he has to deal with many and varied farms; he decides each case separately according to the importance of the sheep on the farm. If the sheep are merely used to clean up cow pastures they would be charged less per week than sheep which are given the pick of the pastures. Based upon costs on the Wye College farms, it is reasonable to accept 2½d. per ewe per week as the grazing charge at present and ¾d. per lamb. Sundry items (such as dipping, shears, medicines, depreciation of troughs and fences, marking paint) will amount to about 5/– a head. Let us be bold and make an attempt to summarize our capital requirements for a flock of 400 ewes, with prices at an average level:—

CAPITAL REQUIRED FOR 400 EWES

	£	£	s.	d.
110 ewe tegs at	6	660	0	0
105 one-lamb ewes at	5	525	0	0
95 two-lamb ewes at	4	380	0	0
80 three-lamb ewes at	3	240	0	0
10 rams at	15	150	0	0
Wages of one full time shepherd for year at £5 (includes overtime, cottage, etc.)		260	0	0
Feeding stuffs 1¼ cwt. for ewe and 1½ lambs at 16/– per cwt. (these are pre-war quantities)		560	0	0
Sundries, 5/– per ewe		100	0	0
Grazing for 400 ewes for 52 weeks at 2½d. per ewe per week ..		217	0	0
Grazing for 600 lambs for 14 weeks at ¾d. per lamb per week ..		26	0	0
		£3,118	0	0

Many criticisms can be levelled at the above figures, but the writer's intention is to give some idea of the capital required; the figures are based on 1947 prices. No charge is included for any additional labour.

Cost of Keeping a Ewe for a Year.

Purchased feeding stuffs are charged to the ewes at cost price, home-grown concentrated foods (such as oats and beans) are usually charged to the ewes at their market value, mangels and fodder crops at their cost of production and grazing as already described. The manual, horse and tractor labour can be calculated from time sheets and the depreciation on the ewes is calculated in the stock account. The results are best summarized by reproducing the average cost in recent years of keeping Half-Bred ewes on the Wye College farms.

COST OF KEEPING HALF-BRED EWES ON WYE COLLEGE FARM, 1938–44

Based on 1,826 ewes

	£	s.	d.	%
FOODS:				
Purchased cakes and meals—				
30 lb. for ewe (War level of feeding)		3	3	7·3
25 lb. for lambs (War level of feeding)		2	1	4·7
Home-grown corn 18 lb. for ewes (War level of feeding)		1	8	3·9
Mangels— 433 lb. for ewes		4	2	9·4
Clover pug* and hay		1	0½	2·3
Grazing 2·13d. per week ewes...		9	4	21·1
·44d. per week lambs			9½	1·8
Total food	1	2	4	50·5
LABOUR:				
Man and horse		7	4	16·5
DEPRECIATION ON EWES		10	8	23·9
OTHER ITEMS:				
Rams, dip, equipment, medicines, etc.		4	1	9·1
Gross cost per ewe per year ...	2	4	5	100·0
Less Wool		10	0	
Net cost per ewe per year ...	1	14	5	
Value of lambs reared per ewe	3	0	7	
Average profit per ewe per annum	1	6	2	

Number of lambs tailed per 100 ewes put to ram: 147.

It is obviously unwise to generalize about the cost of keeping sheep and the returns from so doing, because the costs and returns are obviously very different on 'all grass' farms producing fat or store lambs and on arable farms producing ram lambs. The author feels, however, that sufficient has been said in the various sections of this book to enable any reader so disposed to work out the cost of production of any particular type of sheep on any particular type of farm. Mr. James Wyllie in costing a large number of farms in south-east England, has found many items of interest during the last twenty years. In his report No. 10 (see list of references) he states that the average result of 16 farms between 1923 and 1939 was a loss of 9½ per cent on the capital invested. Twelve of these 16 farms showed a loss, though it should be pointed out that the market was steadily falling. During this period sheep sales amounted to 87 per cent of the revenue and wool up to 13 per cent. Seventy-two per cent of the cost of upkeep was food, 20 per cent labour and 8 per cent other items. Wyllie's Report No. 11 for the Wye College farms only shows that during the years 1926–30 a profit of 17·7 per cent was shown on the capital invested in Half-Bred ewes. The ewes showed a profit of 13s. 9d. per head during this period, although, being a young flock, they only averaged 138 lambs tailed to every 100 ewes mated. The depreciation during this time was very high (14s. 10d. per head) and the lamb sale prices, in the light of subsequent prices, very low (46s. 9d.). Other breeds of sheep were kept on the College farm during this period, but in view of the fact that they were in a minority and subject to some changes (too complicated to justify space here), the results are not stated.

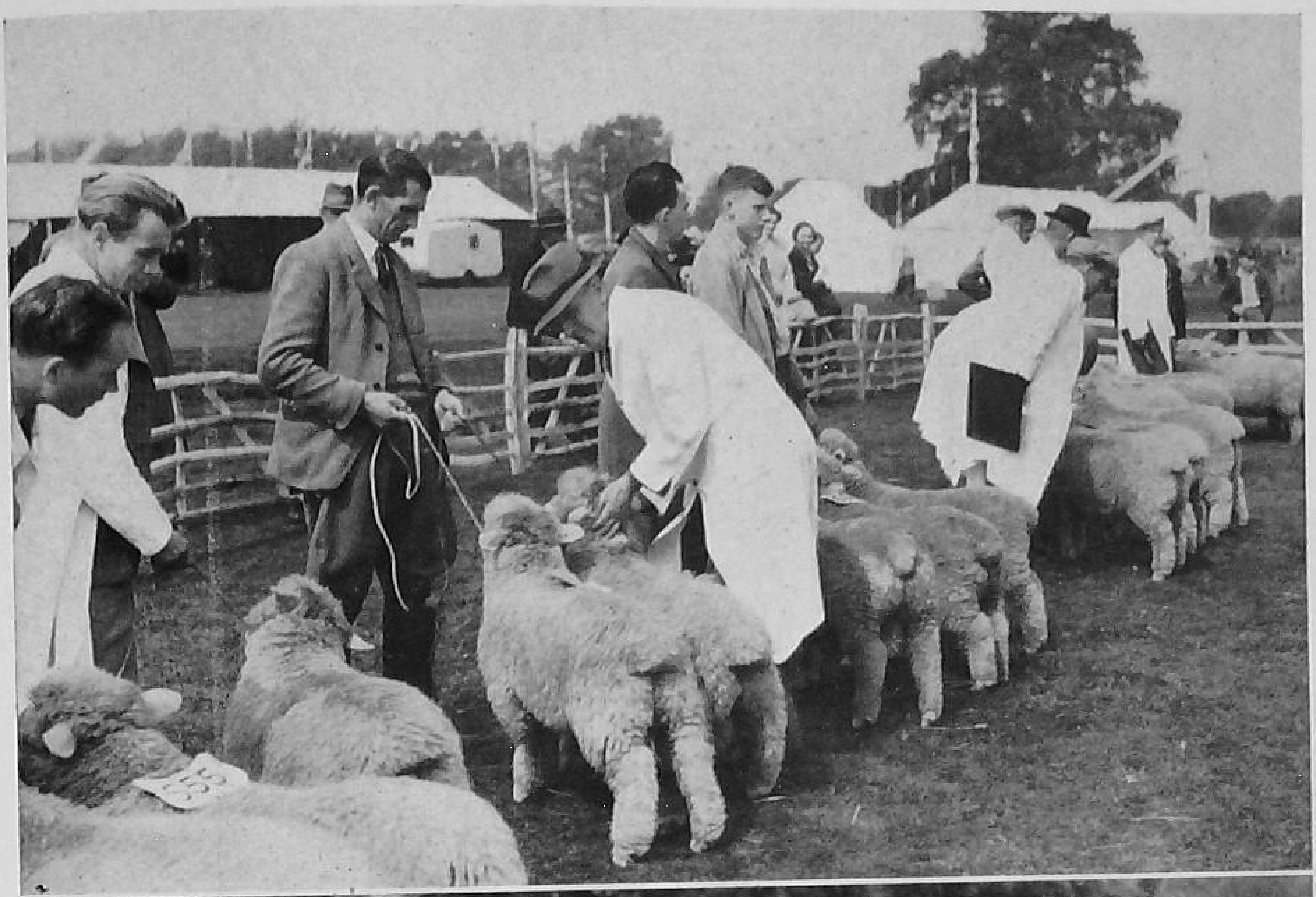
Wyllie's Report No. 21 shows the Wye College results for the period 1930–34, when a loss of 3s. 9d. per ewe was incurred for 1,126 ewes put to the ram. These were the results despite the fact that the excellent lamb average of 158 lambs tailed per 100 ewes mated was achieved during this time. Wyllie's Report No. 25, based on 16 farms and covering 75 farming years from 1929–36, shows an average loss of £65 per farm per year. In 42 farming years from 1933–36 a profit of £48 per year was shown. The figures given so far are not calculated to encourage anyone to rush into sheep farming! Wyllie's Report No. 28 is, however, more encouraging again. For the period 1934–38 on the Wye College farms 1,232 Half-Bred ewes were put to the ram, produced 153 tailed lambs per 100 ewes mated and the ewes showed an average profit of 15/– per head. The cost of feeding the ewes and her lambs was 25/– per year, the cost of labour was 5s. 10d., depreciation 8s. 3d., and sundry items 4s. 5d. The lambs sold for 52s. 7d. per head average, weighing 80·6 lb. per head at 126 days old. The profit shown represents an interest on capital of 25½ per cent. Report No. 33 for the Wye College farms for the years 1938–44 shows the cost of feeding per ewe as 22s. 4d., labour 7s. 4d., depreciation 10s. 8d., sundries 4s. 1d., and the returns from wool 10s. 0d. per ewe. For 1,826 ewes mated during this period an interest on capital of 41 per cent was shown, the profit per ewe per year was 26s. 2d., and the number of lambs tailed was 147 per 100 ewes mated.

On the Wye College farms in fourteen years up to Michaelmas 1944 the lamb average had been 151·6 lambs tailed for every 100 ewes mated. The loss between tailing and sale had been about 2 per cent. 6·4 per cent of the ewes had died, and throughout this time the ewes had been run very thickly on the ground, namely 3⅓ ewes per acre.

The above reports are invaluable and give a wealth of knowledge of accurate costings and sheep management and the author knows no other source of such detailed information.

The selling price of sheep is fixed at the present time for some months in advance. The sheep are graded whilst alive and paid for at a predetermined price per lb. estimated dressed weight. If one works on an average dressed weight of 50 per cent of the live weight, it is possible to calculate the selling value of lambs and other sheep, though very immature lambs would fall below 50 per cent and mature sheep rise above it. As this book goes to press the price of sheep is very high and the prospects for the grass flock are very good; let us hope that they may remain so.

* The chaff resulting from the threshing of seed of wild white clover and of ryegrass.

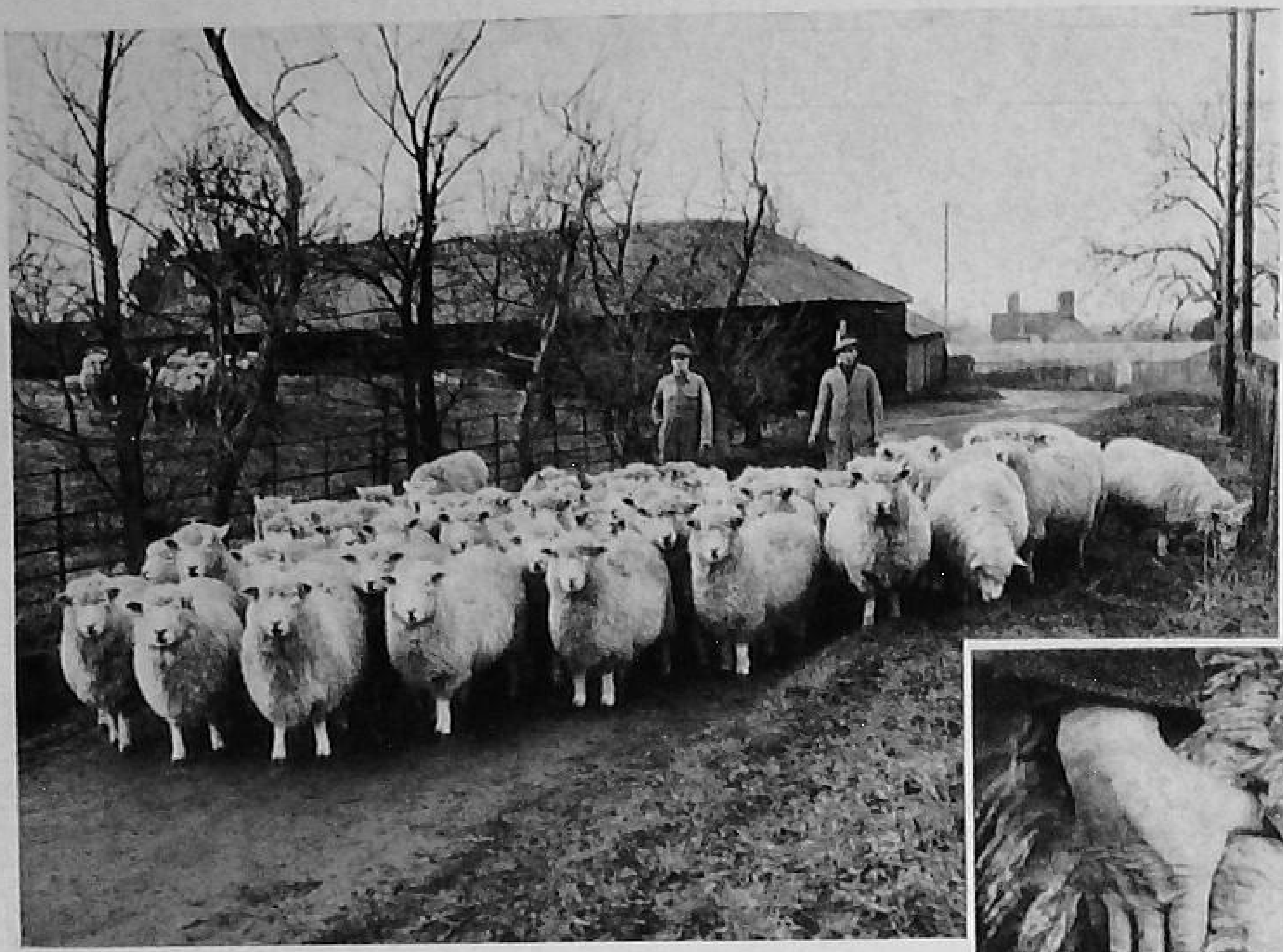


SHOWS AND CONTESTS STIMULATE THE INDUSTRY

Above : LAMB PENS AT AN AGRICULTURAL SHOW

Below : YOUNG FARMERS AT A SHEEP-SHEARING COMPETITION

Photographs: Kent Messenger



PEDIGREE KENT OR ROMNEY MARSH STUD EWES.
BRINGING IN SHEEP FOR SORTING

Above : CHECKING THE QUALITY OF THE FLEECE OF A KENT SHEEP

PEDIGREE KENT EWE TEGS SOLD FROM KENT TO A FARMER IN SOUTH AFRICA

BRITISH BREEDS OF SHEEP

Photographs: Farmer & Stockbreeder. Courtesy: Nackington Farms

MIXING TABLE FOR LIQUID

Liquids are usually recommended to be used in strengths such as 1 in 50 or 1 in 10. The smaller quantity is easier to measure in fluid ounces and the larger in pints. The following table gives these proportions:—

Liquid	*Water*	*Liquid*	*Water*
1 in 5–4 ozs. to	1 pt.	1 in 70–4 ozs. to	14 pts.
1 „ 10–4 „	2 pts.	1 „ 75–4 „	15 „
1 „ 15–4 „	3 „	1 „ 80–4 „	16 „
1 „ 20–4 „	4 „	1 „ 85–4 „	17 „
1 „ 25–4 „	15 „	1 „ 90–4 „	18 „
1 „ 30–4 „	16 „	1 „ 95–4 „	19 „
1 „ 35–4 „	7 „	1 „ 100–4 „	20 „
1 „ 40–4 „	8 „	1 „ 105–4 „	21 „
1 „ 45–4 ,	9 „	1 „ 110–4 „	22 „
1 „ 50–4 „	10 „	1 „ 115–4 „	23 „
1 „ 55–4 „	11 „	1 „ 120–4 „	24 „
1 „ 60–4 „	12 „	1 „ 125–4 „	25 „
1 „ 65–4 „	13 „	1 „ 130–4 „	26 „

Measurement of Medicines

A useful table to remember is:—

1 teaspoonful	=1 to 2 drams.
1 dessert-spoonful	=3 to 4 drams.
1 table-spoonful	=½ to 1 ounce.
1 egg-cupful	=1¼ to 1½ ounces.
1 cupful (small)	=5 to 7 ounces.
1 cupful (large)	=8 to 11 ounces.
1 tumblerful (average)	= ½ pint (Imperial)

RECOMMENDED MEDICINES

Fly Dressings

1. 4 per cent phenol crystals in whale oil.
2. 5 per cent solution of zinc sulphate in water.
3. 5 parts lysol, 4 parts commercial carbon tetra-chloride, 9 parts household paraffin, 2 parts pine tar oil. Parts by volume. Mix 1 part of the mixture with 4 parts of water.

Stomach and Intestinal Worms

1. Phenothiazine.
2. 1,000 c.c. water, 50 c.c. nicotine sulphate, 50 grammes copper sulphate. This is enough for 50 adult sheep, ewes receiving 20–30 c.c.; lambs 2–3 months old 5–7 c.c., 3–6 months 7–10 c.c., 6–9 months 10–15 c.c. Dose three times at 10-day intervals if heavily infected.

Foot Rot

1 quart Stockholm tar, 2 oz. copper sulphate, tablespoonful of lysol.

Hoven or Bloat

One teaspoonful of bicarbonate of soda, one teaspoonful of ground ginger in 4 oz. warm water. If there is no benefit from this use trochar and cannula.

DIPPING DATA

The operation of dipping is so important and so worthwhile, apart from the fact that it must be done by law, that the following notes are made:—

1. Comply with local regulations as to dates and number of dippings.
2. Notify the police three days before the dipping.
3. Always start with a clean empty bath and adhere rigidly to the instructions on the packet of dip. Make certain that the strength is correct.
4. If you are using a bath for the first time mark its sides with the gallons in hundreds. Water can be measured into the tank in a 40-gallon oil drum.
5. If the type of dip is one which tends to settle stir at intervals during dipping.
6. Change the dip if it becomes dirty. It is useless dipping sheep in liquid approaching liquid manure.
7. Rest the sheep before and after dipping.
8. Lower the sheep rump first into the dip, giving it a push head forward at the last minute to make quite certain it cannot go in on its back.
9. Make certain that every animal is immersed for long enough to soak the wool to the skin.
10. Push the sheep's head under gently for a short time, but do not hold it under.
11. In autumn dipping, when the fleeces are longer, do not dip the sheep when wet as this dilutes the dip.
12. Do not dip too soon after shearing. For one thing, any shearing cuts must be healed before dipping is carried out, and for another, the growth of a few weeks' wool helps to hold the dip.

Crossbreeding. The mating of two pure breeds.

Cull. A sheep slected for removal from the flock.

Ewe tegs, same thing as Gimmers. Female sheep from about 1 year old until they produce their first lambs at 2 years old.

Fat lamb, lambs which are sold fat whilst still running with their mothers.

Folding, sheep fenced off by hurdles, wire or nets on to a small portion of an arable crop or ley, the fold being moved at frequent intervals.

Flushing, the process of getting ewes into improving condition before mating.

Gestation period, the period between service by the ram and lambing.

Shearling, ewe from first shearing until her first lambing.

Teaser, a ram used for finding ewes which are 'on heat' but prevented from serving them.

Wether lambs, castrated male lambs from birth until about a year old.

Wether tegs, castrated male lambs from about a year old until about 2 years old.

SECTION IV

GOOD PIG-KEEPING

by

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INTRODUCTORY NOTE

No section of British farming suffered more from the War than the pig industry. The number of pigs in the country was reduced to a mere fraction of the number in 1939; the industry must be completely rebuilt and reconstruction must be on sound lines if it is to play its full part in the national economy.

The conditions necessary for a healthy pig industry received careful study in the years before the 1939–45 war and prior to the launching of the Pig Marketing Scheme. These conditions were enumerated by the Pig Industry Council and by the Ministry of Agriculture and Fisheries (1932)*. In this book the working of organized marketing prior to the war and during the war are discussed.

A detailed account is given in this section of the breeding, feeding, management, marketing and housing of all types of pig. The killing and curing of bacon pigs is discussed. It is impossible in a book of this length to deal with the results of the countless experiments which have been carried out in recent years, but reference is made to the more important results and an extensive bibliography is given at the end of the volume.

We are in a difficult transition period. The future of conditions governing feeding stuffs, buildings and other requirements are unknown and so is the future Government policy regarding imports of pig meat and feeding stuffs.

The British breeder of pedigree pigs has developed his work to a very high standard and pigs have been exported from this country to almost every part of the world. The descriptions of breeds in the present volume are given as far as possible without prejudice.

The pig is a most economical flesh-producing animal and almost every part of its body can be used in the production of one or more of many popular forms of food. A flourishing pig industry with its bacon factories is a material help in providing employment, quite apart from the men employed on farms and in food-preparing mills. Let us hope that Government policy will provide the necessary conditions for this industry to flourish.

This section is designed to enable students to gain a comprehensive knowledge of pig production and marketing. It explains to ex-servicemen and others contemplating pig-keeping, some of the intricacies of the work. Those already engaged in pig-keeping will find help, particularly in the tables and references at the end of the book.

The author wishes to acknowledge the advice given to him by Mr. V. C. Fishwick. The illustrations for the numbered figures are from line drawings made by the author's daughter and Miss E. A. Shearlock, to whom he extends his thanks.

* For literature see page 685.

HOME PRODUCTION AND IMPORTS

Here are outlined the objects of pig-keeping and figures for the home production and imports of pig meat are given. The pork trade is discussed and a description given of the ideal pork pig. The bacon trade is reviewed and an outline of its history and its future prospects is given.

THE ultimate object of pig-keeping is the production of pork and bacon. There are four kinds of herd:—

1. Herds in which the primary object is the sale of gilts and boars to be used for breeding.
2. Herds in which the object is the sale of pigs to other pig-keepers to be fed and sold as pork or bacon.
3. Herds in which the breeding stock is kept to produce the litters, which are to be turned into pork and bacon on the farm on which they are born.
4. Fattening herds in which store pigs are purchased for fattening as pork or bacon.

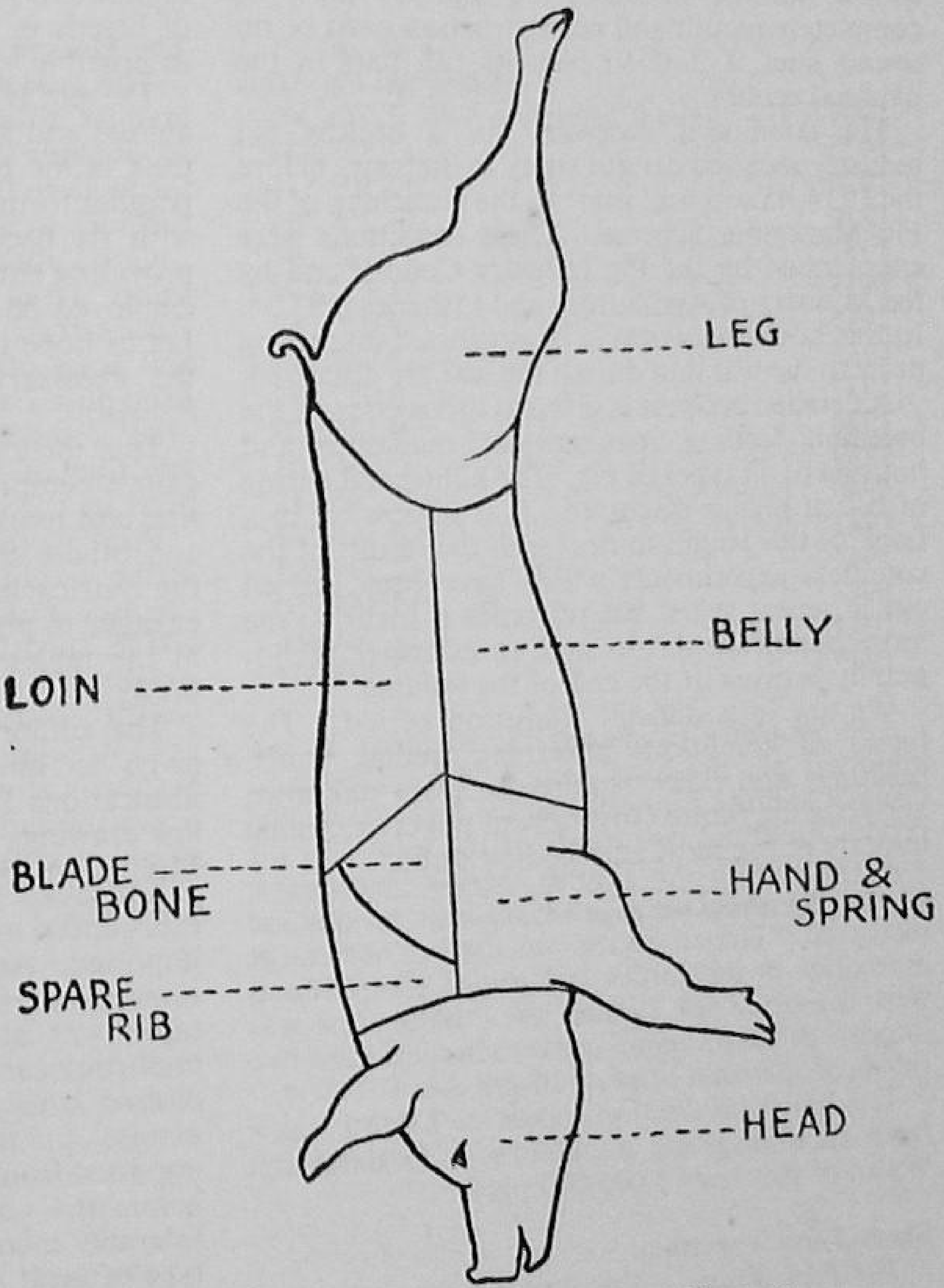
Pigs can either be fed on waste products, of which swill is the most commonly employed, or on concentrated foods in a national emergency, when concentrated foods are scarce, pigs usually have to subsist on waste products because the concentrated foods are required for human consumption or for milk production, so during such times the pig population falls to a number that can be supported mainly on swill and other waste products.

Reduction of Population.

Home Production: Figures of home production of pig meat during the 1939–45 war are, at the time of writing, confidential, but the figures for some of the years before the war are shown in Table I. It is obvious that home production fell during the war, because the bulk of the pre-war pig food was obtained from imported pig foods, from the by-products of imported wheat and from by-products of home grown wheat and barley. The increased percentage of the wheat grain which has been included in the national loaf, coupled with the heavy reduction in imports of pig foods has caused a considerable reduction in the pig population. Assuming that the war-time figures are eccentric, it matters little that they are not available for publication at the moment. The available figures for home production are shown in Table I.

TABLE I

Year		*Cwt. of Home Produced Pig Meat*
1909–13	(*Annual average*)	4,981,000
1924–1925	(June–May)	6,853,000
1932–1933	,,	6,687,000
1934–1935	,,	6,713,000
1935–1936	,,	7,697,000
1936–1937	,,	7,616,000
1937–1938	,,	7,083,000



A COMMON WAY OF DIVIDING A PORK CARCASE

FIG. 1

These figures show that the annual production of pig meat at home varied comparatively little. The sub-division of this total production into pork and bacon is very difficult, chiefly because bacon curers, particularly in the Midland area, sometimes sell parts of their bacon carcases as

pork; in addition to this, there is a large quantity of pig meat cured and consumed on farms which is not recorded. As far as can be estimated rather more than one half of the total production is consumed as fresh pork and the remainder as bacon, ham or other processed goods.

Imports. Pig meat in its various forms arrives in this country from many parts of the world; fresh pork, frozen pork, salt pork, bacon, hams and other products are all imported. In order to give a comparison with Table I, the figures for imports for the corresponding years are shown in Table II.

TABLE II

Year	*Cwt. of Imported Pig Meat*
1909–1913 (*Annual average*)	7,916,300
1925 ..	12,838,849
1926 ..	12,106,516
1930 ..	11,258,794
1931 ..	13,125,292
1933 ..	11,137,898
1935 ..	9,022,967
1936 ..	8,748,517
1937 ..	9,057,597
1938 ..	9,116,529
1939 ..	9,266,101
1940 ..	6,245,113
1941 ..	8,366,228
1942 ..	12,394,695
1943 ..	14,454,730
1944 ..	16,494,036
1945 ..	9,099,764

The countries producing the majority of our imported pig products were U.S.A., Denmark, Canada and the Netherlands, the first two named producing about two thirds of the total. In the war years, with the Danish market inaccessible to us, the proportion of Canadian production increased. Tinned bacon was used in very large quantities in the forces and tinned pig products were imported for civilian use. Before the war imports of bacon represented rather less than two thirds of the total imports of pig meat.

The home production shown in Table I, came from an average pig population in England and Wales of just over 3,000,000 pigs.

Short-Term Variation.

The Pork Trade. The demand from the consumer for pork varies considerably from day to day in any given week, and week by week during the year. In normal times, when the housewife can buy what she likes, the demand for pork increases during periods of cold weather and decreases in milder weather. The short-term variation does not affect the producer because the retailer with his cold storage is able to bridge over any gaps in the demand. Seasonal demand on the other hand does affect the producer, because pork does not keep so well in hot weather as beef or mutton and in any case is not such a palatable dish during the Summer months. From May to September the pork trade is usually rather poor, price reaching its lowest level in June, July, August and September.

Pork is obtained from carcases ranging from 60 lb. dead weight to 140 lb., dead weight. In pre-war days in the North and Midlands, the demand was for the larger carcases 100–140 lb. some of which were partly cured for bacon. The Southern and London markets on the other hand preferred the carcases of smaller pigs. In this part of the country carcases weighing 70–100 lb. were popular.

The Modern Demand.

The modern demand for pork, as with bacon, favours a lean joint with small bone and the modern pork pig is becoming more and more like the modern bacon pig, though the animal is killed for pork at a lighter weight than it is for bacon.

Good pork carcases can be produced from the leaner types of Berkshire and Middle White breeds, from a cross between a Large White boar and sows of one of these two breeds and also from pure Large Whites, Essex and almost all the other breeds. The keynote of success is in the selection of suitable breeding stock, which will produce the lean type of pig that is required.

Prior to the war the price per lb. of pork fell as the weight of the pig increased, the 60–80 lb. carcases making more money per pound than 100 lb. carcases and so on. In many districts the weight of a pig is given in scores (20 lb. dressed weight) so that 60–80 lb. carcases are spoken of as 3–4 score carcases. In other districts the butcher's stone of 8 lb. is taken as the unit by which the carcase is described, i.e. a 64 lb. carcase would be called 8 stone.

The greater part of the meat sold as fresh pork is produced in this country, but a small amount is imported. At one time this imported fresh pork came from Holland and Ireland, but the Dutch trade was stopped to obviate the danger of importing carcases infected with foot and mouth disease which might start an outbreak of the disease in this country. Frozen pork was imported from New Zealand and other dominions before the war and the quantity has been considerably increased since 1939, however, but this type of meat has proved unpopular and only the war has caused its use to be increased. Salted pork was imported before the war from Denmark, U.S.A. and Canada and temporarily surplus joints and carcases are often salted by butchers in this country as a means of preserving them for later sale.

Figure 1 shows a common method of cutting up a pork pig and gives the names of the joints. If butchered in this way a 90 lb. dressed carcase of pork would yield the following joints of approximately the weights shown in Table III.

TABLE III

Name of Joints	*Weight of Joints* lb.	oz.
2 legs	22	8
2 loins	22	8
2 belly cuts	13	10
2 bladebone cuts	4	7
2 hands and springs	11	4
head	6	13
2 spare ribs	8	14
	90	0

The Prime Porker.

The Type of Pig Required for Pork. A prime porker must weigh from 60–80 lb. dead weight and be the carcase of a castrated male or a female before mating. The middle portion of the carcase from the first rib to the aitch bone must be moderately long, but not too long to afford a good depth of loin. The line of the back must not be hollow, the back fat even and of an estimated depth of not more than 1″ nor less than ¼″ at any point behind the shoulder. Thick lines or streaks of fat should be absent from the visible portion of the lean and indications of lean must be visible between the ribs. The shank must be short, bone fine and the hand and ham well fleshed down to the knees and hocks. The head and collar must be light and the ribs well bent. The vertebræ must be of a fresh, pinky colour and capable of being split down the centre with a sharp, heavy knife. The fat must be white and firm to the touch; when pressed with the thumb, the resulting identation should remain visible for a few minutes. The texture of the lean meat must be fine and not rough or fibrous. There must be no excess of internal fat—the kidneys should have a thin covering of fat. The rind must be thin, flesh-coloured, perfectly smooth, not sticky, pliable and free from deeply rooted bristles and must be devoid of any skin pigmentation. The whole carcase must be perfectly clean and dry, free from blemishes, bruises, blood stains and congealed blood and must be skilfully dressed with all loose pieces cut off. The tongue must be slightly drawn through the side of the mouth to allow full drainage of throat and head.

Bacon Keeps Well.

The Bacon Trade. There is a comparatively steady demand for bacon throughout the year; most bacon is eaten as a breakfast food and consequently hot weather does not cause so much reduction in consumption as in the case of pork, which is eaten later in the day. Bacon keeps well and is consequently easier to handle than pork.

On the production side there is considerable fluctuation because pigs which become heavy enough to be killed as pork during May, June, July and August are usually retained by their owner and sold when they reach bacon weight. This applies to the majority of the pigs in spring-born litters and causes an exceptionally large number of bacon pigs to reach the factories during the period August to November. Most home produced bacon is only cured to last a comparatively short length of time, so that during the winter months the quantity reaching the retailers from the factories will be lower and the quantity of imported bacon reaching the retailer must be higher. If the bacon was cured to keep for a longer period and storage space was available, the supply of home-produced bacon sent to the retailer could be evenly spread out over the whole year.

Bacon is obtained from carcases ranging from 140 lb. dressed weight to 220 lb. dressed weight. The killing and curing processes are fully described in Section VI, but it should be mentioned here that the 'Wiltshire' cure requires carcases not exceeding 180 lb. dressed weight and the 'Midland' cure pigs of over 180 lb. dressed weight.

The modern demand is for comparatively lean bacon, because fat is not liked by present day consumers and also very fat rashers tend to shrivel too much when cooked.

British Curers.

No better bacon is produced in the world than the best quality bacon produced by British Curers. Unfortunately, prior to the introduction of the Pigs Marketing Scheme a very large proportion of the pigs which were sent to the British bacon factories were those pork pigs that were surplus to the requirements of the pork market and many of them were too short and carried more fat than an ideal bacon pig should. No attempt was made to supply the factories with a uniform type of pig. Moreover, because pigs made a higher price for fresh pork than they could command for bacon, the pork market was kept supplied even though that meant starving the bacon factories during the winter months. Uneven supply to bacon factories was, therefore, due to the uneven demands of the pork trade over the twelve month period. The result of this was that British cured bacon varied greatly in quality, the supply was irregular and acquired a bad reputation among retailers and housewives alike. The dissatisfaction of the British housewife was quickly noticed by the Danes, and they were quick to profit by it.

Towards the end of the last century the Danes began to make a study of the British bacon market and to find out the wishes of the British housewife. They appreciated the fact that an exporting country was in a strong position, because only the really good quality bacon left the country and the poorer quality could be consumed at home. In order to satisfy the British demand the Danes concentrated on a certain type of pig, cured it in their factories in a standard manner, graded the bacon carefully and then

exported to England only those sides which were up to the standard required. In this way they built up a large, highly organized bacon industry second to none in the world and they captured the British market for bacon. Their representatives were to be found in Britain studying the demands of the British market, noting any change in the public taste and studying the condition and distribution of the carcases on arrival in Britain. Suitable pedigree stock was bought by the Danes in England and taken to Denmark to cross with the local Landrace breed, which was also greatly improved by selection. In order to maintain a reliable supply of pure-bred animals of both breeds State Breeding Centres were set up in 1895. In order to test the subsequent performance of litters bred at the Breeding Centres, selected pigs were sent to Pig Testing stations where economy of food consumption was studied; the carcases of these pigs were very carefully examined. The information obtained at the Breeding Centres and the Pig Testing stations formed an invaluable and complete record which began with particulars of the fecundity of the sow and went on to give details about the carcase of her progeny.

The result of this most efficient organization was demonstrated plainly by a comparison of the pig populations of Denmark and England and Wales prior to the inauguration of the Pig Marketing Scheme. In 1933 Denmark, with a population of only about 3½ million had 3¾ million pigs, whereas England and Wales with a population of 38 million had only 3 million.

Government Action.

The Danes had established such a hold on the British Market that, when it was decided to expand the British bacon production, Government action was necessary to enable the output of British factories to obtain a footing on the home market. Therefore, concurrently with the launching of the Pigs Marketing Scheme a regulation was brought into being regulating the quantity of imports of bacon and hams. It was necessary for the Pigs Marketing Board to inform the Ministry of Agriculture of the number of bacon pigs that it was proposed to produce, in order to enable the Government to inform exporting countries how much of their bacon we proposed to take. On account of this advance information being necessary, a contract system was set up, under which producers were required to sell their bacon to the Pigs Marketing Board on a yearly contract. This enabled the Ministry of Agriculture to forecast the number of bacon pigs to be produced each year.

In order that home-cured bacon should hold its place on the home market, it was necessary for it to be reasonably uniform in quality. The system of grading pigs at the factory and making payment according to carcase quality was introduced to encourage producers to supply the right type of carcase. This policy was surprisingly successful and resulted in a marked improvement in the pigs sent to the factories. This, combined with the fact that the scheme provided the factories with a fairly regular supply of pigs, enabled them to put on the market two things which are essential if the market is to be held. As a result, by 1937 the prejudice against British bacon had been overcome. Following the introduction of the Pigs Marketing Scheme there was a steady increase in the number of bacon pigs produced annually; it had reached 1¾ million when the war broke out in 1939.

Emergency Measure.

The grading system was abandoned during the war and payment was made on a weight basis; the prices were so arranged that they encouraged the production of pigs up to 9 score dead weight, because large pigs could utilize wartime food, such as swill, more economically than smaller animals. This must, however, be regarded merely as an emergency measure and it seems certain that some system of grading and payment on carcase quality will be re-introduced as soon as conditions return to normal.

Present Production.

Future Production Outlook. The present production of pigs has fallen to an extremely low level because of the shortage of pig food. Barley and Maize normally form an appreciable portion of the pig's food and a large quantity of both these cereals is imported. These imports have, to a large extent, ceased since 1939 and the supplies available for pig food have been reduced to very small amounts. Foods such as rice meal, tapioca meal, soya bean meal, maize by-products, ground-nut cake and so on are almost unobtainable. Wheat by-products are in short supply owing to the use for human consumption of war-time national flour; this includes 90 per cent of the wheat, whereas before the war only 80 per cent, and sometimes slightly less, of the wheat remained in the white flour; the material removed was called millers' offals. Consequently, the amount of millers' offals available at the present time is lower than before the war and a large amount of what is available is being fed to dairy cattle because of the high priority of the dairy industry. Fish meal and meat meal are in reduced supply. The position is likely to alter greatly during the post-war period when production throughout the world gets back into its stride and adequate shipping is available.

It is in the national interest to expand the pig population as rapidly as possible, because owing to the great fertility of the pig, this is the quickest possible means of increasing the national meat supply. The more meat that can be produced at home, the greater the saving in foreign exchange, because it is more economical to import food to feed pigs in this country than to import the pig meat ready made.

The pig is an economical user of the by-products of human food, such as small potatoes, surplus potatoes, cereals, fruit, milk by-products, bakers' waste and household swill. Much of this material is as yet untapped. Whilst consuming such foods, the pig is also using as litter straw which is frequently an embarrassing surplus commodity, and is converting it into valuable manure for the production of arable food crops.

The labour required to look after the pre-war population of about 3½ million pigs is estimated as being equivalent to 20,000 men working whole-time. Many pigs it is true are produced on farms where the cowman or some other man looks after the small number of pigs kept in addition to his main job, but if all these hours are totalled up, some 20,000 whole-time employees are required for the 3½ million pigs mentioned. Many thousand men are employed in butchers' shops, bacon factories, sausage factories and other trades associated with the pig population. It seems odd in these days of labour shortage to mention this employment as an advantage, but the day may shortly dawn when it will be an advantage again.

Future Controls.

Future Marketing Policy. The Marketing Board considers that upon return to normal conditions it will be necessary to have control of all pigs and to regulate imports and to guarantee prices with a definite relation to the cost of production as well as to make adequate provision for giving warning of a change of price. The Board should include a number of producers able to safeguard the interests of the producer; as an alternative, representatives of the producer should be called upon to serve on the Board.

Before the 1939–45 war many pigs were sold in the open market and at certain times of the year a producer would have the unsatisfactory experience of seeing other producers making higher prices for pigs as pork in the open market than he was making at the bacon factory. This state of affairs can only be avoided if the Marketing Board controls all pigs; with the Board controlling all pigs, contracts would be unnecessary and their removal would remove a constant bone of contention. Producers disliked contracts but they were necessary in order to forecast future home deliveries and to regulate imports accordingly.

It is almost impossible to grade a bacon pig fairly when it is alive. The thickness of the fat is so critical that only an examination of the dressed carcase can produce anything like a satisfactory estimate of its value to the retailer. Objections from producers have, in the past, been mainly the result of a few unfair factories, who gave unfair carcase weights or graded carcases lower than they should have been graded. The difference between live weight and dead weight varies considerably and it would be impossible to use an average figure without penalizing the good producer and benefiting the bad producer; weight of the dressed carcase is, therefore, the only weight which can be used. Live weight could be increased by feeding a short time before weighing and this would lend itself to abuse if the live weight were the basis of payment.

The Board considers standardization of factory procedure to be essential, particularly with regard to the interval between arrival at the factory and slaughter, feeding during the wait of the pigs at the factory, the actual dressing process and the time of weighing after slaughter.

The Suggested Marketing Plan.

1. All pigs should be delivered direct to the place of slaughter and not sent to collecting points. Collecting points cause a delay which lowers the condition of the pigs before killing and results in a loss of weight.
2. Slaughtering points should be so situated that pigs can be killed within a reasonable distance of the farm. These slaughtering points should be capable of handling all types of pig—not only those for pork and bacon, but also fat sows and other pigs to be used for the manufacture of sausages and other products. The slaughtering points should be capable of handling all pigs from the area in which they are situated. It is suggested that there should be a weekly killing of 600 pigs to be economical.
3. The long distance transportation of pig meat is to be preferred to that of live pigs. Allocation of pigs to the pork or bacon trade should take place after killing and dressing, the carcases being distributed according to the purpose for which they are best suited.
4. Area Pig Officers, Slaughterhouse Controllers and Graders should be trained and appointed.
5. Pigs should be paid for on dead weight according to carcase grade. Prompt payment is advisable and it is suggested that this should be done direct to the producer from the place of slaughter.

National Asset.

The Pedigree Trade. Discussion in this section has been almost exclusively confined to the pork and bacon trades and indeed these are the most important items from the point of view of the number of pigs involved. The pedigree pig trade, as with all other types of livestock industry in this country, is, however, a national asset and British pedigree pigs have long been exported to all parts of the world. Breeders of pedigree pigs dispose of their surplus gilts and boars to other breeders as a result of advertisement or at an advertized sale of surplus pedigree breeding stock. The prices realized during the war years have been high and they are likely to remain high for some years to come because a great deal of building up is required in the home industry and because a very large number of pigs is needed in the war-ravaged countries of Europe.

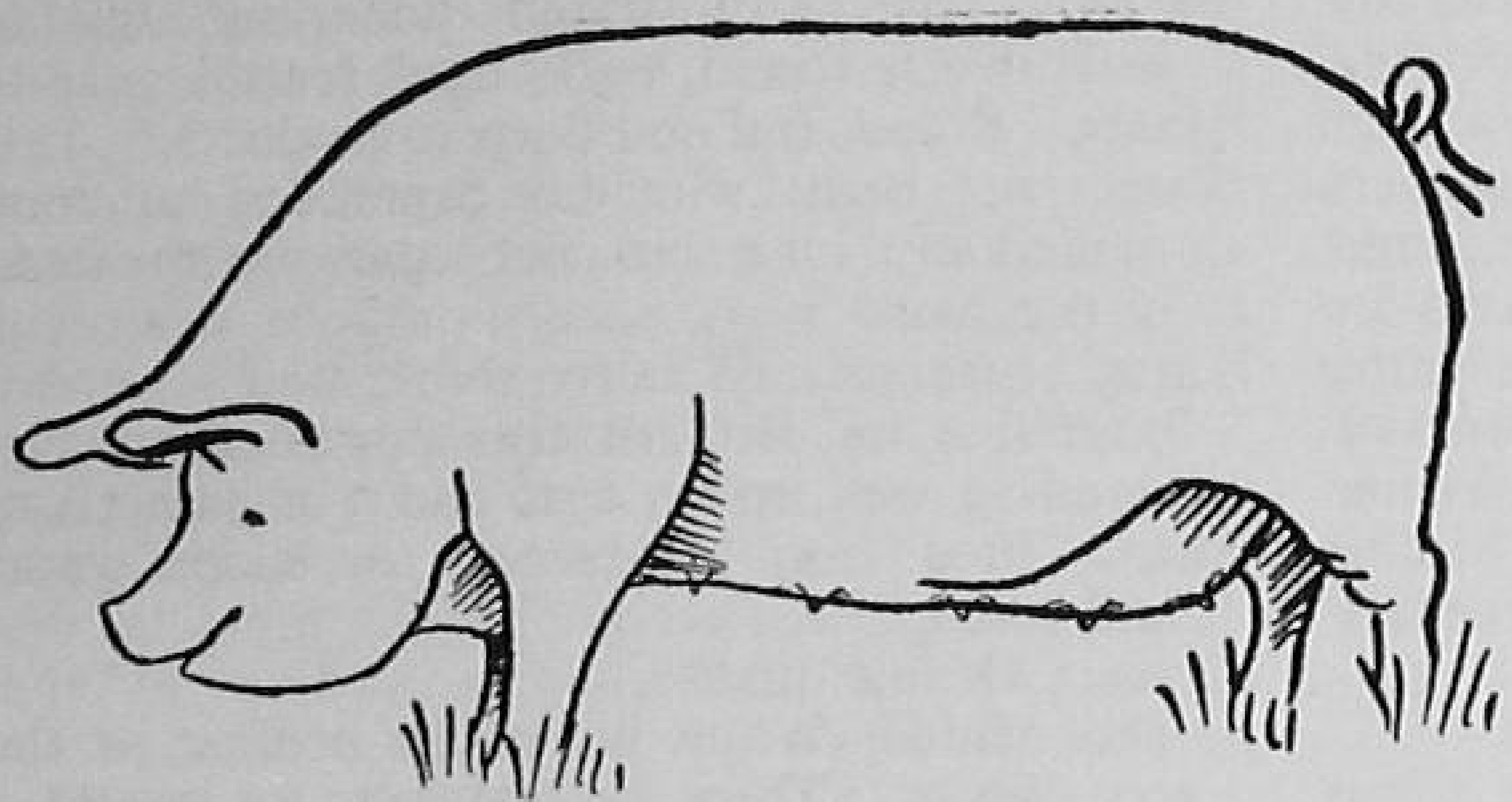
BREEDS

The general characteristics of the chief British breeds of pig are described. Here the author discusses the following: The Large White, the Middle White and the Wessex Saddleback breeds. The Berkshire, the Tamworth and the Large Black are next dealt with and finally the Gloucestershire Old Spot, the Welsh and the Essex Breeds are described.

THERE is no space available here in which to describe the origin of the pig. It is quite obvious that the pig was once wild, that it roamed the forests and ate such food as acorns and Beech mast, but the information, though interesting, does not justify inclusion in a book of this nature.

Breeding and Selection.

Our modern breeds have attained their present form as the result of careful breeding and selection



LARGE WHITE SOW
FIG. 2

during the past 70 years. The National Pig Breeders' Association, founded in 1884, has been followed by other breed societies at subsequent dates.

Mention of a book on the origin of the pig will be found in the literature of the subject in the list at the end of the book.

The prospective pig farmer must decide what breed he is going to keep; this is difficult. He must study the conditions of market and climate in the locality in which the farm is situated. Local pork and bacon firms and local markets should be visited, as well as some of the large pig farmers in the neighbourhood. From them it is possible to find out the strength of local prejudice and how far it is necessary to adhere to local custom. At the present time there is a national tendency to favour fewer breeds and one or two breeds of pig popular in the 19th century have almost ceased to exist in this country.

A Great Reputation.

The Large White. This breed is also referred to as the Large White Yorkshire, though its characteristics have altered considerably since the day in 1774 when a pig of the Yorkshire breed was killed in Cheshire weighing 12½ cwt. alive and 10¾ cwt. dressed. In those days the ears hung forward over the eyes, whereas the modern pig of this breed has what are known as prick ears. The original Large White was improved in West Yorkshire and in 1868 classes were started at the Royal Show for Large White pigs. With the passage of years the breed has acquired a great reputation in this country and abroad as a bacon pig. It produces the fairly lean, long side of bacon which the modern curer demands. It is notable that the excellence of Danish bacon, which we imported before the war in such large quantities, owed much to the Large White blood.

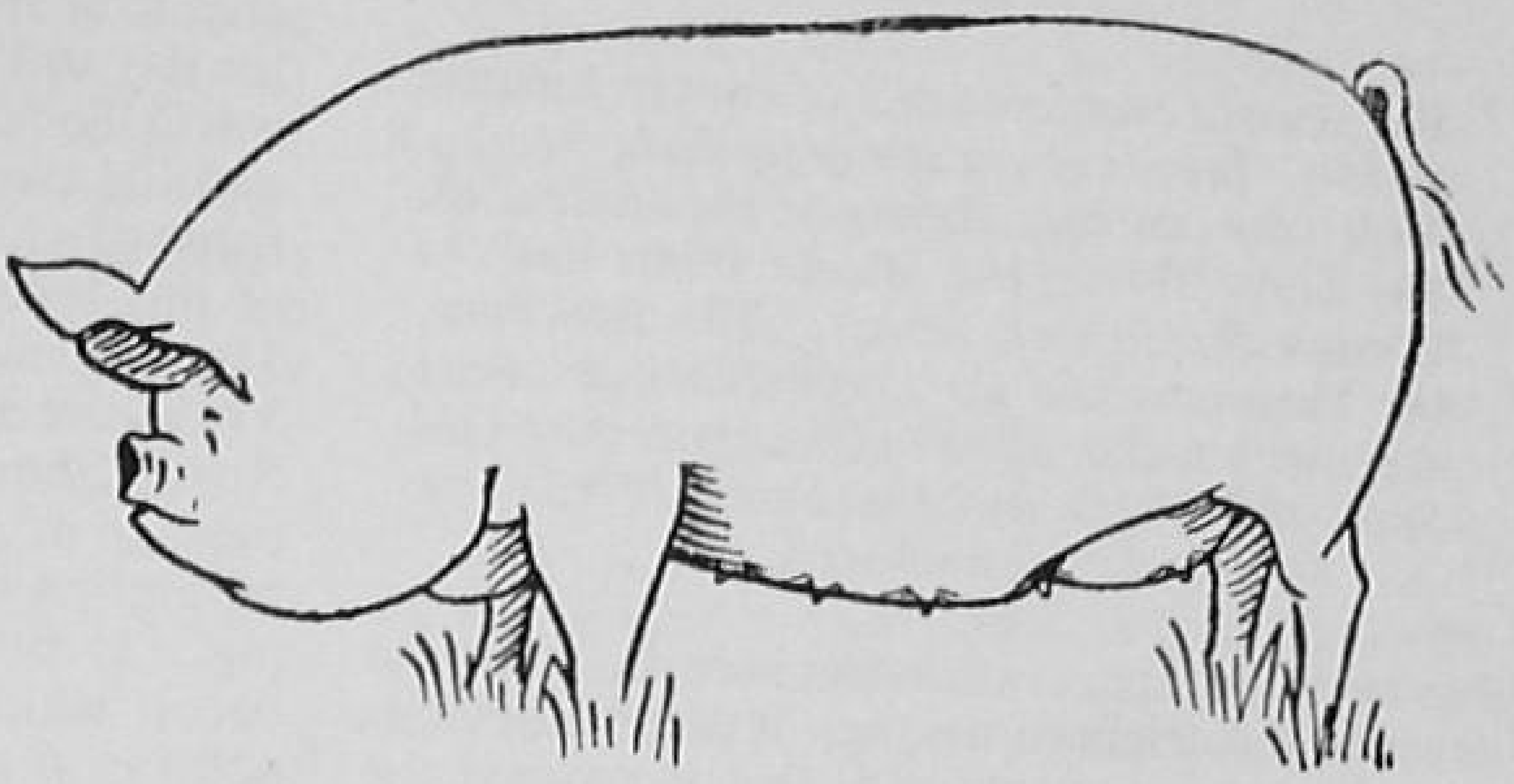
The standard of excellence laid down by the National Pig Breeders' Association for the Large White is as follows:—

HEAD. Moderately long, face slightly dished, snout broad, not too much turned up, jowl slight, wide between the ears.
EARS. Long, thin, slightly inclined forward and fringed with hair.
NECK. Long, fine and proportionately full to shoulders.
CHEST. Wide and deep.
SHOULDERS. Level, obliquely laid, medium width, free from coarseness.
BACK. Long, level and wide from neck to rump.
LOIN. Broad.
QUARTERS. Long and wide.
HAMS. Broad, full and deep to hocks.
TAIL. Set high, stout and long, but not coarse, with tassel of fine hair.
RIBS. Well sprung and sides deep.
BELLY. Full, but not flabby with straight underline and with at least twelve sound, well placed teats.
FLANK. Thick and well let down.
LEGS. Straight and well set, level with the outside of the body, with flat bone.
PASTERNS. Strong and springy.
FEET. Strong and even.
ACTION. Firm and free.
SKIN. Fine, white, free from wrinkles, black hairs and black spots and as free as possible from blue spots.
COAT. Long and silky.

The sows are docile and are, on the whole, good mothers. The actual number of pigs born per litter is probably higher than any other British breed, though the losses between birth and weaning appear to be higher than other breeds. The breed is hardy and is to be found in nearly all the pig producing countries of the world. While Large White pigs have proved their worth as far north as Finland they are also to be found on the equator. Some 200 large White pigs per

year are normally exported for breeding and the number has reached even as high as 585. In 1935, according to Ministry of Agriculture (1938) figures, approximately 95 per cent of the premium boars in this country were Large Whites.

The superiority of the Large White boar as a sire of pigs intended for bacon pigs is emphasized in a report of the grading at an Eastern Counties factory (Punter, A. W., 1936), and in the report of a survey of pig production in S.W. England (Wiltshire, C. C., 1936).



MIDDLE WHITE SOW

FIG. 3

Bacon Pig.

The Middle White. The breed was evolved in Yorkshire where the Large White, Middle White and Small White all intermingled. The Small White is now extinct, the Large White has become the accepted bacon pig *par excellence* and the Middle White is accepted as an excellent pork pig, reaching killing weight early and with a high percentage of lean meat to bone. The modern type of Middle White, which is somewhat longer than that of twenty years ago, can be used for either pork or bacon, though for the latter purpose a Large White + Middle White cross is considered better than the pure Middle White.

The standard of excellence of the Middle White as laid down by the National Pig Breeders' Association is as follows:—

HEAD. Moderately short, free dished, snout broad, jaw straight, jowl light, eyes set well apart, wide between the ears which should be fairly large and inclined slightly forward and outward and fringed with fine hair.

NECK. Fairly light, medium length, proportionately and evenly set on shoulders.

SHOULDERS. Light, sloping and aligned with legs and sides. Free from coarseness.

BACK. Long and level to root of tail with well-sprung ribs.

SIDES. Deep and level.

FLANK. Firm and aligned with sides.

BELLY. Thick and straight underline, with at least twelve sound, well placed teats.

HAMS. Broad, full and deep to hocks.

TAIL. Set high, with no depression at root, moderately long but not coarse with tassel of fine hair.

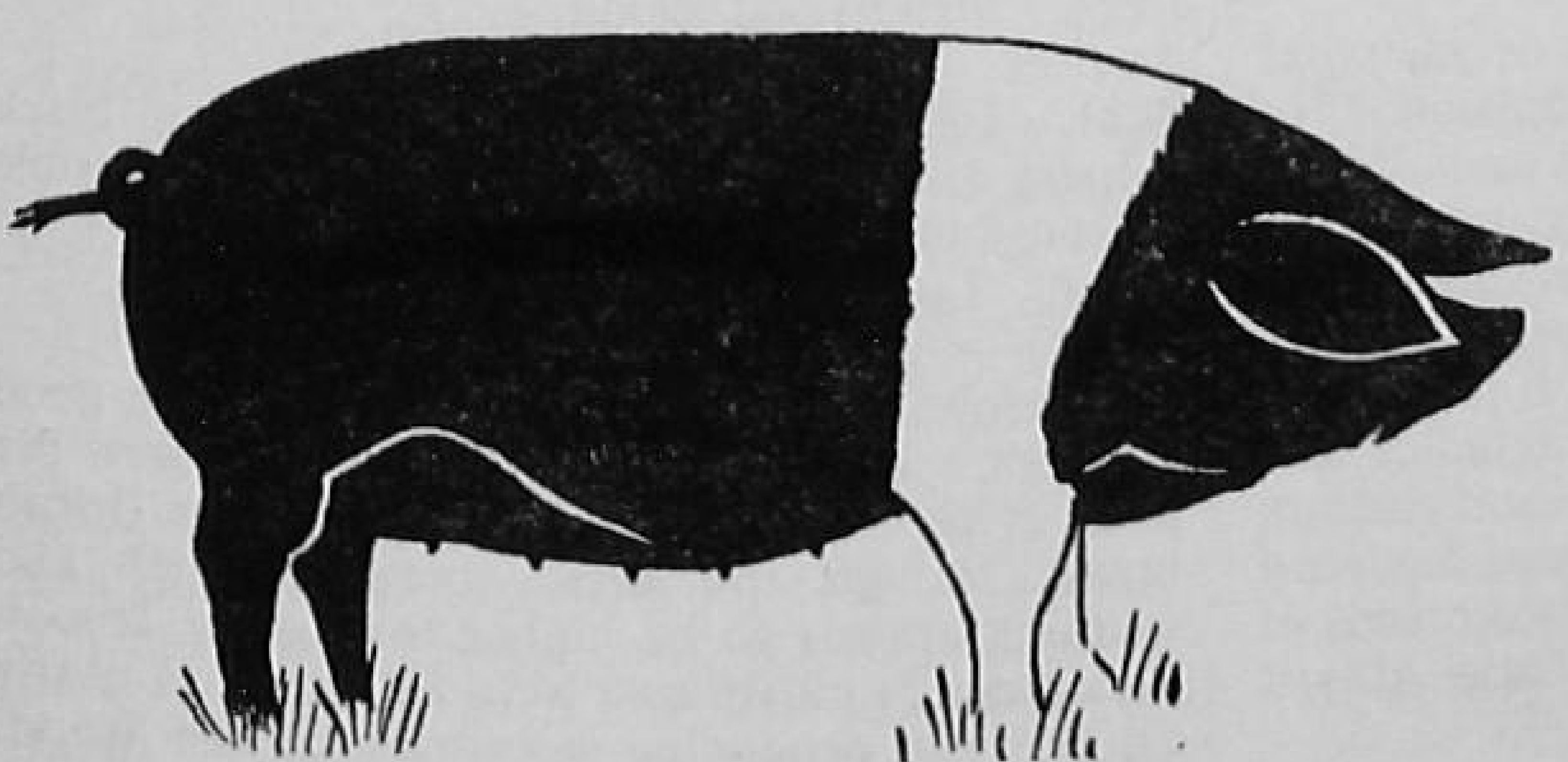
LEGS. Straight and fairly short, well set apart, bone fine and flat, pasterns short and springy, standing well up on toes and a good walker.

SKIN. Free from coarseness, wrinkles, spots and roses.

COAT. Of fine quality.

The Middle White is not so prolific as the Large White. There is, however, on record a Middle White sow which had 28 litters in which she produced over 200 pigs.

The breed is hardy, grows rapidly and is excellent for improving the quality of larger and slower maturing breeds. Sows and boars have been exported to almost every part of the world. In 1931 export certificates were issued for 135 Middle White pigs.



WESSEX SADDLEBACK SOW

FIG. 4

A Grazing Pig.

The Wessex Saddleback. This pig, as its name implies, had its origin in the West country. Its place of origin was Dorsetshire, it has spread widely all over the country. It has acquired a great reputation as a grazing pig that can be killed at almost any age. The standard of excellence for the Wessex Saddleback is as follows:—

COLOUR. Head and neck black, white over shoulders and fore-legs. Continuous belt of white

hair over fore-legs and shoulders. Body, hind quarters and hind legs black.

HEAD. Fairly long, snout moderately long and straight, face very slightly dished, medium width between ears; under jaw clean-cut and free from jowl; nose black and velvety in appearance.

EARS. Medium sizes, with forward pitch, setting well on to face, but not obscuring view, furnished with plenty of fine hair.

NECK. Fairly long and muscular.

CHEST. Wide and deep.

SHOULDERS. Fine, sloping and well set.

LEGS. Strong and shapely, with good bone, well set on each corner of the body.

PASTERNS. Strong and sloping.

FEET. Strong and of fair size.

BACK. Long and straight.

LOIN. Strong and broad.

TAIL. Stout and long, with tassel of long black hair.

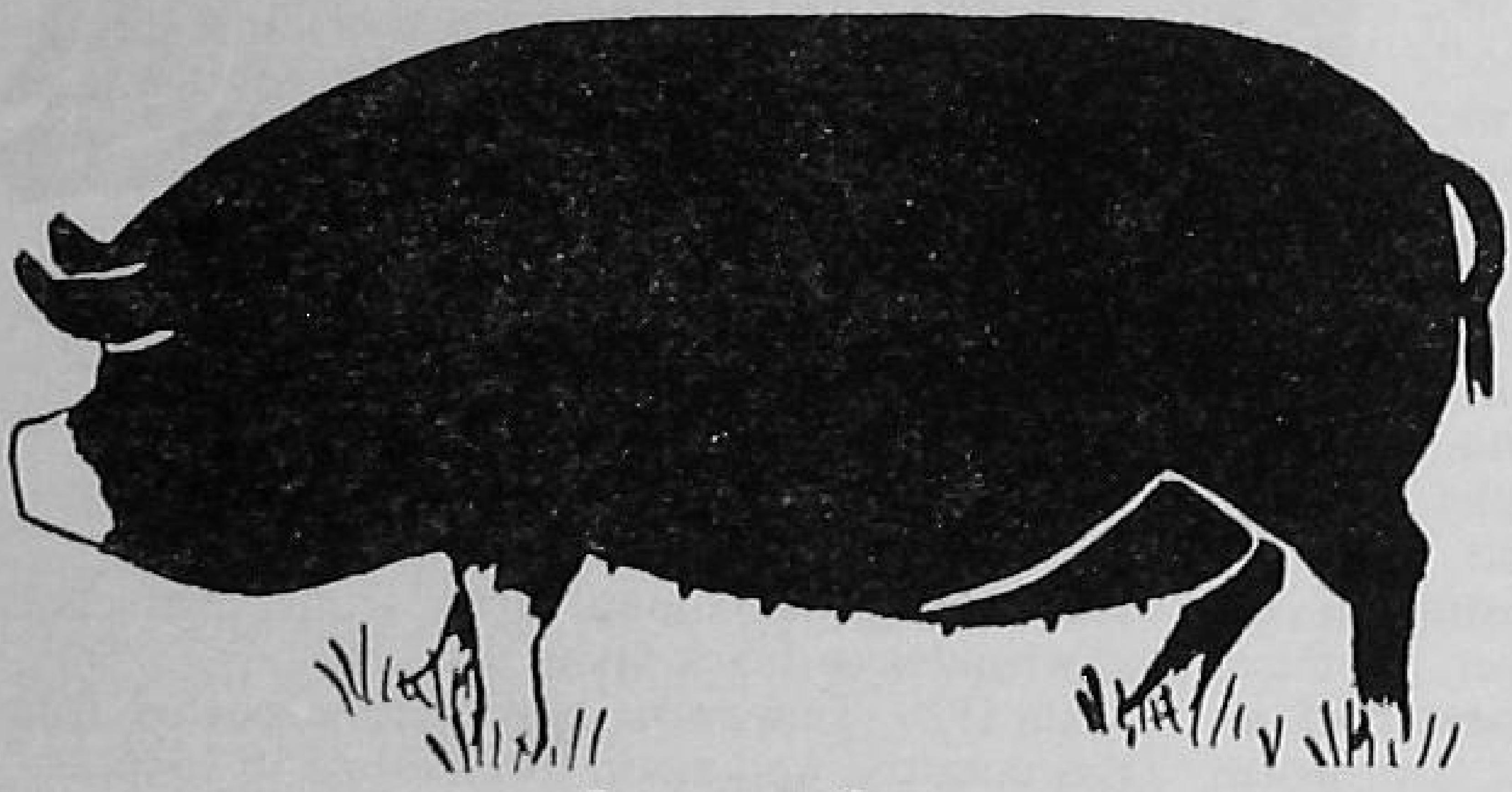
SIDES. Long and deep.

RIBS. Well sprung and extending well up to flank.

BELLY. Deep, with straight under-line, and with at least twelve sound, well placed teats.

FLANK. Full and well let down.

QUARTERS. Long and wide.



BERKSHIRE SOW
FIG. 5

HAMS. Broad and full, deep to hocks.

COAT. Abundant, long and straight.

ACTION. Firm and free.

Boars should have masculine appearance and strong points.

Objectionable Features. Curly coat, coarse mane, crown on back, short or turned-up snout, over-heavy broad shoulders, wrinkled skin, inbent knees, hollowness at back of shoulders. Colouring—white on any part but the saddle. Prick ears, slouch, floppy or papery ears.

The breed is very hardy and it is an excellent grazer. The sows, which are prolific, are good mothers. This can be seen from the official records of the National Pig Breeders' Association for the Wessex breed, which are given below. It will be seen that there is a clearly marked improvement in the average number of pigs reared per littler for the years 1929–1939 but that the progress was not maintained during the war years.

TABLE IV.

	No. of Litters	*Average No. of Pigs born*	*Average No. of Pigs Reared per Litter*
1929	520	9·60	7·64
1930	471	9·65	7·74
1931	599	9·73	7·98
1932	727	9·62	8·12
1933	860	10·13	9·29
1934	835	10·08	8·37
1935	1,094	10·11	8·32
1936	1,465	10·08	8·33
1937	1,713	9·91	8·25
1938	1,768	9·86	8·33
1939	1,975	9·83	8·22
1940	1,690	9·73	8·20
1941	1,587	9·52	8·21
1942	2,347	9·53	8·19

In 1935 export certificates were issued for 38 Wessex Saddleback pigs.

Valuable for Crossing.

The Berkshire. This breed, as its name implies, had its original home in Berkshire. In 1850 early pioneers began improving the breed and in 1884 the British Berkshire Society was founded. The breed, as it originally became known, was too fat to suit modern requirement. Breeders are now producing lighter-shouldered and longer pigs, so that in addition to providing a very fine pork pig the breed is now valuable for crossing for bacon production. The breed is valuable also for crossing with larger and slower maturing breeds; in New Zealand and Australia, a Berkshire + Tamworth cross is very popular. The standard of excellence for the Berkshire, as given by the National Pig Breeders' Association, is as follows:—

CHARACTER. A combination of the following definitions denoting type, quality, breeding and masculinity in the case of boars, and femininity in the case of sows and gilts.

HEAD. Moderately short, face dished, snout broad; wide between the eyes and ears. Ears fairly large, carried erect or slightly inclined forward and fringed with fine hair. Jowl light.

NECK. Fine, evenly set on shoulders and free from wrinkles.

SHOULDER BLADES. Fine and well sloping. Special notice to be taken regarding this point in the case of females.

LEGS AND FEET. Short, straight and strong, set wide apart, standing well on toes, and a good walker.

BACK. Long and level. Tail set high.

SIDES. Level and deep; ribs well sprung.

HAMS. Broad, wide and deep to hock.

BELLY. Thick with straight underline, deep through heart, and with at least twelve sound well placed teats.

BONE. Well developed in males and fine in females.

FLESH. Firm without excessive fat.

SKIN. Fine and free from wrinkles.

HAIR. Long, fine and plentiful, with absence of mane, especially in females.

COLOUR. Black, with white on face, feet, and tip of tail.

IMPERFECTIONS. Crooked jaw. In-bent knees. Rose back.

OBJECTIONABLE FEATURES. Black tail. Black feet.

By comparison with the Large White and Wessex the breed is not prolific (see page 659), though a good proportion of the piglings born is reared to weaning.

Berkshire pigs are exported from this country.

An Excellent Forager.

The Tamworth. This breed which is characterized by its golden red hair, originated in the West Midlands and there is still a comparatively high proportion of Tamworth herds in that area. The outstanding characteristics of the breed are that it is an excellent forager, produces a very high proportion of lean meat and an excellent bacon carcase as do most Tamworth crosses. In Australia and New Zealand. Berkshire + Tamworth cross-bred pigs are very popular. Some strains of Tamworth are prolific, though the records of the National Pig Breeders' Association (page 659), show that in the actual number of births this breed was the lowest of the five breeds recorded by the Association. The percentage of piglings reared to weaning was, however, higher than in any other breed. The standard of excellence laid down for the breed by the National Pig Breeders' Association is as follows:—

COAT. Golden red, abundant, straight and fine, and as free from black hairs as possible.

HEAD. Not too long, face slightly dished, wide between ears, jowl light.

EARS. Rather large, with fine fringe, carried rigid and inclined slightly forward.

NECK. Light, medium length, proportionately and evenly set on shoulders.

CHEST. Wide and deep.

SHOULDERS. Light, free from coarseness, and in alignment with fore-legs below, and with side as seen from in front.

LEGS. Strong and shapely, with good quality bone and set well outside body, pasterns short and springy, standing well up on toes.

BACK. Long and level, slightly arched traversely above shoulders.

LOIN. Strong and broad.

TAIL. Set on high and well tasselled.

SIDES. Long and deep.

BELLY. Straight underline, with at least twelve sound well placed teats.

FLANK. Full and well let down.

HAMS. Well developed, deep, full to hocks, and giving a tense appearance.

LARGE BLACK SOW

FIG. 6

SKIN. Flesh coloured, free from coarseness, wrinkles or black spots.

In 1929 Tamworth pigs were exported from this country, and again to Palestine in 1946.

Docility of the Sows.

The Large Black. The Breed Society was formed in 1899 and the breed had been recognized and bred pure for many years before that, so that it may fairly claim to be one of the older known pure breeds. The breed is supposed to have originated in the East. The chief advantages of the Large Black are the docility of the sows which are excellent grazing animals and rear a large proportion of the pigs born. Owing to their dark skin these pigs are not affected by the sun in hot climates to the same extent as white animals; at the same time they are hardy and withstand well the rigours of the English climate. Butchers and bacon factors prefer the sows to be mated to a Large White boar; this cross is often nearly white or blue and white in colour. The Large Black

boar is sometimes used on Large White sows. According to East Anglian records (A. W. Menzies-Kitchin, 1937), Large Blacks produced 8·6 pigs per litter and reared to 6 weeks only 7·1 which is not a very favourable report. One of the most serious disadvantages of the breed is seedycut (see Glossary).

Show records indicate that the average daily gain of this breed compares favourably with that of others.

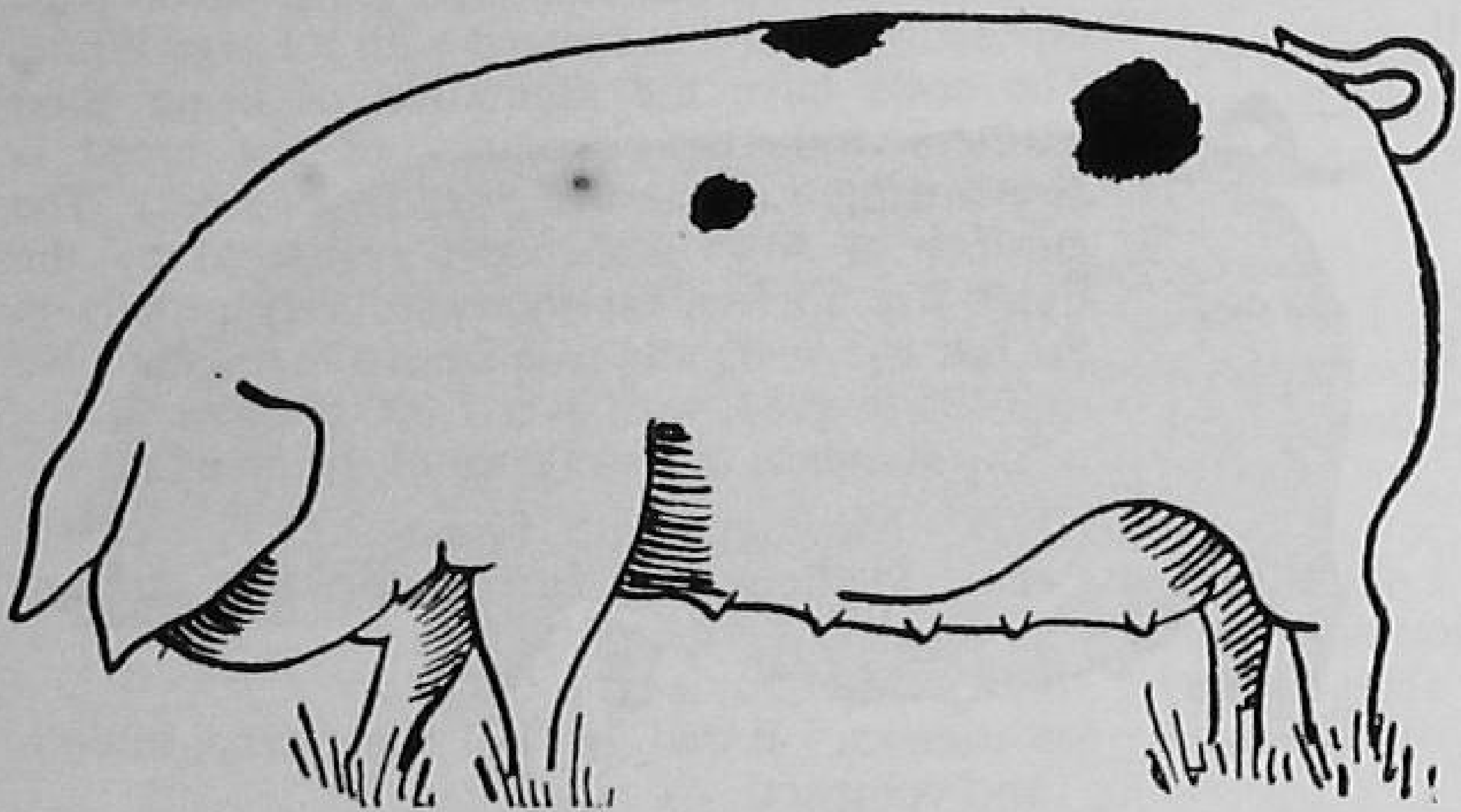
Pigs of this breed have been exported to almost every part of the world.

The official scale of points as published in the booklet issued by the Large Black Pig Society is as follows:—

No. 1. 5 points:—
HEAD. Well-proportioned. Medium length, wide and clean between the ears.
EARS. Long, thin and well-inclined over the face.
JOWL AND CHEEK. Freedom from jowl. Strong under-jaw.
No. 2. 10 points:—
NECK. Medium length and smooth.
CHEST. Wide and deep.
SHOULDERS (Important)—Fine and in line with the ribs.
No. 3. 15 points:—
LENGTH (Important).
No. 4. 20 points:—
BACK. Long and level.
LOIN. Broad.
No. 5. 10 points:—
RIBS. Well-spring.
SIDES. Deep.
BELLY AND FLANK. Medium and well developed, with an adequate supply of efficient teats.
No. 6. 20 points:—
HAMS. Large and well-filled to hocks.
QUARTERS. Long, wide and not drooping.
TAIL. Set high and thick set.
No. 7. 10 points:—
LEGS. Well-set, straight and flat. Fine bone.
PASTERNS. Strong.
GENERAL MOVEMENT. Active.
No. 8. 10 points:—
SKIN. Blue-black. Fine and soft.
COAT. Fine and soft, with moderate quantity of straight, black, silky hair.
GENERAL QUALITY AND CONFORMATION.

Objections.
HEAD. Excessive jowl, narrow forehead, dished or moley nosed.
EARS. Thick, coarse, cabbage-leafed or flopping.
COAT. Coarse, curly or bristly mane.
SKIN. Thick, wrinkled or sooty black.
NECK. Coarse. Collar.
SHOULDER. Heavy and coarse shield.
LEGS AND FEET. Crooked.
CONDITION. Excessive fat to be discouraged at Shows.

DISQUALIFICATIONS. Any other colour than black. Curly coat. Rose on back.



GLOUCESTER OLD SPOT SOW
FIG. 7

Good Results on Swill Alone.

The Gloucestershire Old Spot. Illustrations of a spotted pig appeared in Agricultural books in 1804. The breed appears to share its origin with the Berkshire, which in its early history was a spotted pig. The Berkshire breeders eliminated the spots, whereas the breeders of the Gloucester Old Spot pigs retained them. In spite of its antiquity the breed did not have a herd book until 1913. It has become noted for its scavenging properties and during the 1939–45 war has produced good results on swill alone. All the records of the Breed Society were lost in the air raids on Bristol and the Society was reorganized in 1942. Pigs of this breed have been exported to Central Europe, Africa and Australia. It is hardy, adaptable and combines reasonable prolificacy with an ability of the sows to rear a good proportion of the pigs produced.

The pig is white in colour with a few large black spots; the Society is at present trying to bring a rather higher percentage of black back into the breed. Seedycut should not, and does not, appear.

The Welsh. Although the Welsh Pig Society was only founded in 1918 to preserve the records and pedigrees of the Welsh pig there is reasonable evidence that the breed is of very considerable antiquity and that there has been no outside blood imported into the Welsh breed. The history of the breed and what it was, are, however, of small importance and the capabilities of the breed at the present day are what really matter.

Bacon Curing.

One of the best known bacon curing firms recently said that the Welsh pig approaches closely to the Danish Landrace pig and provides the curers with carcases of outstandingly good qualities.

Pigs of this breed have only appeared in commercial classes since 1929 and since then have won successes, which can be studied in the *Pig Breeders Annual*, the *Farmer and Stockbreeder Year Book* and other publications. The live weight gain per day recorded by Show animals of this breed has been beaten by several other breeds.

In recent years the breed has spread outside Wales into England and Scotland and has also been exported to countries overseas.

The standard of perfection laid down by the Society is as follows:—

HEAD. Of medium length, fairly wide between the ears.

NOSE. Fine and straight.

JOWL. Light and clean.

EARS. Long, thin and drooping, and inclining well over the face. " Floppy " ears which hang listlessly down over the cheeks are very objectionable.

NECK. Moderately long and fine.

SHOULDERS. Light, oblique and neat. Free from wrinkles or coarseness. (Great importance is attached to the possession of neat, light shoulders and forehead.)

CHEST. Wide and deep.

BACK. Long and strong, rising to a slight arch over the loins when viewed sideways and slightly arched from side to side when viewed from before or behind. A wide, flat back is objectionable.

SIDES. Deep, well-filled in behind the elbow and in the flank, with well-sprung ribs.

LOIN. Well-developed, firm and thick right through. Not flat.

BELLY AND FLANKS. Thick and well-filled, with a straight underline.

QUARTERS. Long and wide.

HAMS. Large and deep. Well let down and filled to the hocks. Free from wrinkles and coarseness.

TAIL. Well-set and carried, and of good length. Free from depressions at the setting-on.

LEGS. Short, straight and set well apart. Fine in bone.

COAT. White, straight and fine in quality, but rather more abundant than is seen in the majority of other breeds, as this is a peculiarity of the Welsh pig and is regarded by curers as a sure indication of an economical carcase. Coarseness of mane, a serious objection.

SKIN. Fine, soft and free from wrinkles or coarseness.

TEATS. Evenly placed and not less than twelve in number. Rudimentary teats are desirable in boars.

GENERAL TYPE AND APPEARANCE. The type to be encouraged is a lengthy, early-maturing, pleasingly-proportioned, alert and active pig, standing well up on its toes.

Note.—Black or other coloured spots are undesirable, but the presence of a very few minute spots does not constitute a disqualification in an otherwise good animal.

Large White Ulster. This breed is now practically extinct in Northern Ireland and has been replaced by the Large White breed.

Open-Air Conditions.

Essex or Essex Saddleback. This breed, which bears a striking resemblance to the Wessex Saddleback, is said to be descended from the old English pig; it has been bred in Essex for over a hundred years. It is hardy, adaptable and well suited to open-air conditions, producing not only good pork pigs of the lean type required by the modern market, but also high grade bacon pigs, especially when it is crossed with a Large White. The sows have the reputation of being good mothers and the popularity of the breed is demonstrated at sales of pure Essex stock. The number of sows and boars registered by the Essex Pig Society has increased very rapidly in the last five years and rose from 679 sows in 1940 to 3,488 in 1944, with over 1,000 members.

The standard of excellence of the breed is:—

HEAD. Medium length, broad.

EARS. Medium size, carried forward, but not flopped.

NECK. Medium length.

SHOULDERS. Broad, but not open, deep, smooth and compact.

CHEST. Deep, full girth.

BACK. Straight, broad and level.

LOIN. Broad and strong, free from slackness.

RIBS. Well sprung and deep.

SIDES. Deep and full, long and smooth, free from wrinkles.

FLANKS. Full and well let down.

HAMS. Broad, full and well-filled to hocks.

LEGS. Strong, straight, well-set, with clean bone, feet medium size.

TAIL. Strong, well set on.

HAIR. Fine and straight.

COLOUR. Black, with the exception of white belt—free from spots, encircling the shoulder, including fore-legs, white hind legs not higher than hock, white nozzle and white tip to tail.

CONDITION. Uniform covering of flesh, especially in region of valuable cuts.

Objections.

HEAD. Badger face.

EARS. Very erect or floppy.

HAIR. Rose on back or shoulder.

COLOUR. No white belt encircling the shoulder, including forelegs.

FOODS AND FEEDING

Different methods of feeding pigs are described. Meal Mixing is explained. Constituents of feeding stuffs are indicated and we are shown how to work out rations and the quantities of protein and other materials to include. Descriptions and uses of common pig foods are given. Restricted and unrestricted feeding are discussed. The uses of Swill, Green Food and Roots come under review.

The Importance of Food Economy.

SUITABLE rations for different classes of pig are given in the appropriate chapters; hard and fast rules cannot be laid down because current prices and availability of foods will often upset the pig keepers' standard rations. The cost of these rations is three quarters of the total cost of production, so that every care should be exercised in compiling suitable rations from the cheapest suitable foods and then feeding only as much to the pigs as they will clear up and use economically.

Grazing and green food will save a certain amount of meal, but the real saving in meal comes from the powers of observation of an intelligent pigman.

The question of feeding is so important that it will be dealt with at considerable length in this section so that the reader, when he has perused it to the end will be able to calculate rations and effect the economies which are so essential. The number of pounds of meal consumed per pound of increase in live weight is a good indication of the efficiency of the feeding and the pigs. The 7 score bacon pig from weaning to killing increases in weight by 170 lb.; if for each of these pounds of increase the pig consumes ¼ lb. of meal more than necessary to produce it, the pig has consumed 42½ lb. more meal than it should have eaten. This represents 5/4d. per pig at £15 per ton. Differences in commercial herds in the number of pounds of meal per lb. live weight increase range from 2½ to 5 lb. The older and heavier the pig becomes, the greater the weight of meal required to put on 1 lb. live weight.

The alimentary tract of the pig is only about half as long as that of a cow or a sheep, in proportion to the size of the animal. It cannot therefore deal effectively with bulky, fibrous foods. Soda and excess of salt are bad for pigs and consequently swill should be carefully watched for an excess of these substances and materials. Frozen food of any kind should not be fed to pigs.

The pig, like all animals, is greedy and unless adequate trough accommodation is provided, the weaker pigs will not get their fair share of the food. The trough should be empty at the end of 20 minutes; this is the yard stick by which the quantity of food is judged. Stale food should never be left in front of the pigs.

In the present section minerals are referred to several times. This means lime and salt, which are added when necessary to a ration at the rate of 2 per cent. Other minerals may, under special circumstances, be necessary, but the word minerals in this section refers only to lime and salt.

How to Feed.

Method of Feeding.

There are five ways of giving a pig its ration of meal, each of which has advantages and disadvantages. Each method will be discussed in turn.

1. Dry meal in a dry feeder.
2. Dry meal with water poured on to it in the trough.
3. Meal soaked in a bucket for each pen and fed wet.
4. Meal soaked in a large tub and fed wet from buckets.
5. Meal in the form of cubes.

First Method.

1. *Dry Meal in a Dry Feeder.* Dry meal may be placed in a suitable dry feeder. Water is provided in a separate trough and the pigs help themselves to each commodity. If an exact and economical ration is to be fed, the daily ration must be put into the feeders each morning. A large feeder, which is kept permanently replenished, is economical in labour and uneconomical in meal. On fold units and moveable wooden houses the dry feeder is built into the house. Some meal is wasted by wind, by snorts from noses of the pigs and by the pigs putting their feet into the trough. Ordinary troughs can be used for dry feeding but are more wasteful than dry feeders because they are more exposed to the wind.

Less Waste.

2. *Dry Meal with Water poured on to it in the Trough.* This method employs ordinary troughs, but has the advantage that there is less waste of meal, because it is damped by the water. Unless there is some means of shutting the pigs away from the trough until the water is added, considerable waste will still occur; this can be avoided by shutting the pigs into their sty until the feed is ready or by the use of troughs with a swinging shutter.

Minimum of Waste.

3. *Meal Soaked in a Bucket for each Pen and Fed Wet.* Weighed or measured quantities of meal, placed in a bucket for each pen, with the required water added and then left to soak avoid waste of meal, but require a large number of buckets. If only a few buckets are available the feeding period becomes very protracted because the same buckets have to be used for a number of pens. As soon as feeding begins, all the pigs

will become restless until they get their food, so that the time taken to distribute the food should be as short as possible. The employment of this method means accurate rationing and minimum of waste.

Labour Saved.

4. *Meal Soaked in a Large Tub and Fed Wet from Buckets.* Labour in mixing is saved if large quantities of meal are soaked in a large tub. This may be on wheels so that it can be pushed round the sties or the food can be distributed in bucketfuls from the tub. The method has the disadvantage that the quantity of meal given to each pen is not really accurate and may vary from day to day according to the amount of water which has been added to the meal. Several tubs will be necessary so that breeding-pig rations, suckling-sow rations, fatting rations and so on may be mixed separately.

Simple Way of Feeding.

5. *Meal in the Form of Cubes.* Balanced rations sold in the form of cubes were available before the war. They are only for use where pigs are being fed on a clean grass run, or a clean concrete feeding floor (a common thing in U.S.A.) or when they can be placed in troughs and water given separately. This is a very simple way of feeding, but the price of the cubes is the limiting factor. It must be borne in mind that the considerable labour of mixing different meal constituents on the farm is avoided and also the labour of soaking meal; if the cubes are fed on grass there is a saving in the cost of troughs.

The cubes are sold with a declared analysis, but the constituents may be varied according to ruling prices.

Three Feeds.

Time of Feeding. Feeding may take place two or three times daily according to the availability of labour. If possible young weaners should have three meals daily, but it is unlikely, in these times of labour difficulties, that all pigs can be so treated; better progress will certainly be made if three feeds per day can be fed. It is advisable, if practicable, that in cold weather food should be warmed for sows in milk, for young pigs and for fattening stock.

Proper Mixing.

Pig rations usually contain several different constituents. These must be thoroughly mixed and for this a proper mixing floor with a smooth surface is essential. It is usual to set aside one or two periods a week for meal mixing and to mix up sufficient meal each time to last until the next mixing time. Alternatively the ready mixed meal can be obtained from a merchant, but the cost per ton is usually greater than if the ingredients of the mixture are bought separately and mixed on the farm.

The Constituents of Feeding Stuffs.

For practical purposes the following are the constituents of feeding stuffs:—

1. Water.
2. Proteins (also called albuminoids).
3. Carbohydrates.
4. Fat or oil.
5. Mineral matter.
6. Vitamins.

Water for Digestion.

1. *Water.* All foods contain water which is different in amount from 10 per cent in most dry meals to 90 per cent in roots such as mangels. Digestive juices cannot mix freely with completely dry food; the presence of water in the food enables them to do so more freely. Water in the food takes the digested constituents of the food into solution and enables them to pass through the wall of the intestine into the blood stream.

Nitrogen.

2. *Proteins* are complex compounds containing nitrogen. Lean meat, or muscle, is one of protein structures of the animal body and this is built up from proteins supplied in the food. It may be supplied to the pigs from animal sources such as fish meal and meat meal or in vegetable form as in Soya bean meal, peas and beans. Quickly growing animals and milking sows require more protein than stock which, while adult, is neither pregnant nor milking. The protein constituent of the ration is the most expensive to supply; consequently it must be selected with care and used economically.

Starch.

3. *Carbohydrates* exist in pig foods in the form of starch and sugar. Most cereals and also potatoes consist largely of starch. This constituent of the ration is responsible for the maintenance of body heat and production of energy; any surplus after these requirements have been satisfied may be turned into fat in the animal's body.

Body Heat.

4. *Fats and Oils* may be of either animal or vegetable in origin. They are also used in the maintenance of body heat, in the production of energy and if fed in excess are deposited as fat. The production of fat in a pig should be effected from the carbohydrate part of the food and not from the feeding of excessive fats and oils; excess of the latter is likely to produce soft fat.

Growth of the Animal.

5. *Minerals* are necessary for the production of bone in a growing animal, for the production of the fœtus in a pregnant animal and to supply minerals in the milk of a suckling sow. The pig

grows very rapidly and a mineral deficiency is quickly noticeable in the growth of the animal. The cereals, which form the bulk of pig rations in this country are deficient in lime and chlorine, but contain adequate phosphorus and (as far as is known) iodine. In the Middle West of U.S.A. iodine has given remarkable results, but there appears to be no need to feed it in this country. The deficiency of lime and chlorine can be made up by the normal addition of fish meal or meat meal to the ration, but where a vegetable protein is used instead of fish meal both lime and salt should be added. A deficiency of iron causes anæmia in young pigs when a few weeks old; this is fully discussed on pp. 658–665.

Adequate Quantities.

6. *Vitamins.* These accessory food factors, as they are sometimes called, must be present in adequate quantities in pig foods just as much as for any other animal or for human beings. Much has been written on the subject and much remains to be found out. There is no evidence of any serious deficiency of any vitamin in mixed pig rations such as those recommended in this book. No advantage is derived from feeding additional vitamins if sufficient are already present. The only likely deficiences occur where pigs are housed out of the sunlight and with no green food at all. The two vitamins which may then be deficient are A and D. The deficiency of A can be corrected by feeding green food, or, of course, by a run on grass in the summer or by the addition of lucerne meal or codliver oil to the ration in winter. The deficiency of D can be corrected by feeding codliver oil at the rate of ½ an ounce daily for a pig of under 50 lb. live weight or at the rate of 1 ounce daily for larger pigs.

The vitamin strength of the common pig foods is shown below:—

Vitamins

	A	B	C	D	E
Barley	1	2	–	–	1
Maize Meal	0	2	0	–	1
Maize Germ Meal	1	3	0	–	3
Oats	1	2	0	–	1
Weatings	1	2	0	–	2
Beans	1	2	1	–	–
Fish Meal	1	1	–	1	–
Ground Nut Cake	0	1	0	0	1
Dried Yeast	1	3	–	–	–
Pastures and Clovers	2	2	2	1	2
Cabbage	2	2	3	1	1
Carrots	2	2	2	–	–
Mangels	1	1	1	–	–
Cooked Potatoes	1	1	2	–	–
Swedes	–	2	3	–	–
Turnips	–	2	1	–	–
Dried Skim Milk	1	1	–	–	–
Codliver Oil	3	–	–	2	–

0 indicates that no vitamin is present.
1 indicates that some of the vitamin occurs.
2 indicates a good source of vitamin.
3 indicates richness in vitamin.
Blank indicates that no information is avilable.

It will be seen from the table just given that vitamin B is always provided in a normal ration.

How to Work Out a Ration. From what has already been said the reader will have deduced three facts. (1) The mineral constituent is correct if fish meal is used or easily remedied if vegetable protein foods are used. (2) The vitamin content especially where green food is available is no cause for worry. (3) The most expensive item in the ration is the protein and this must neither be wasted nor allowed to be deficient.

Tested Rations.

It is possible to build up pig rations from the figures given on p. 688, but the simplest method of working out a ration is to start with one that has been tested and found satisfactory—any of the standard rations given in this book can be used. If necessary, other foods can be employed, an equivalent quantity being substituted for a similar class of food used in the ration. For example, in a sow ration of 45 per cent Weatings, 45 per cent Barley Meal and 10 per cent Fish Meal the Barley must be reduced owing to shortening supplies. Reference to the pages dealing with foods (*see* page 646), shows that maize meal is a similar food and if necessary reference to p. 688 confirms that its analysis is very similar, so that if the price is suitable it can be employed in the ration to replace up to 20 per cent of the Barley Meal. Wheat Meal may also be used to substitute Barley Meal and so may Flaked Maize up to 30 per cent of the ration. This is a very simple way of altering a ration, but caution should be observed regarding the following points, (a) a feeding stuff should only be used to replace one in its own class, (b) the fibre content of the ration should be maintained in order to provide sufficient bulk to satisfy the stomach of the pig, (c) the quantity of protein must be maintained.

The Quantity of Protein in a Ration. The quantity of protein required per day for growing pigs of different weights has been given by Wood as follows:—

Live weight of Pig (lb.)	Protein in lb. required per day
50	0·3
75	0·4
100	0·5
150	0·6
200	0·6

Rations can be checked from analysis tables to see if they supply enough protein. The ration already discussed (45 per cent Weatings, 45 per cent Barley Meal and 10 per cent Fish Meal)

gives the following quantity of protein:—

	Crude protein	lbs. protein in 100 lb. of rations
	per cent	
45 lb. Weatings	13·0	5·85
45 lb. Barley Meal	6·5	2·92
10 lb. Fish Meal	55·0	5·50
		14·25

Wood states that a 100 lb. pig requires 0·5 lb. protein per day. A 100 lb. pig receives 4 lb. (perhaps slightly over 4 lb.) of this ration per day or 1/25 of the quantity in the calculation. The pig received therefore 1/25 of the quantity of protein (14·25 ÷ 25) or 0·57 lb. which is slightly on the safe side.

Nutritive Ratio.

The proportion of protein in a ration is alternatively indicated by the nutritive ratio. This is the proportion of protein to carbohydrate in the ration. The calculation of the nutritive ratio of a ration is simple with the aid of the necessary tables, but in the last few years the importance attached to the nutritive ratio has declined and modern opinion favours the substitution method, using proved standard rations as a basis; the protein intake per day should be sufficient, but it should not be higher than necessary, because of the high cost of this part of the ration. The nutritive ratio for young growing pigs or breeding sows is 1: 4 to 1: 5, whereas for fattening pigs it is widened to 1: 6 to 1: 8.

Rations for Livestock.

Feeding Stuffs Regulations. The Fertilizers and Feeding Stuffs Act, 1926, stipulates the information that must be given to the pig-keeper by the seller in respect of the common pig foods. The official descriptions of the foods, together with the particulars to be supplied at the time of sale may be found in the Act or are more easily obtained from 'Rations for Livestock' Bulletin No. 48 of the Ministry of Agriculture and Fisheries.

Economical Procedure.

Restricted Feeding. In recent years a change of opinion has taken place regarding the economy of unrestricted feeding of pigs. It was the accepted policy years ago to give a pig as much food as it would eat and the more it ate the more pleased the owner was, because he felt sure that it was an economical procedure. Mansfield and Fishwick have proved that this is not so. Mansfield reduced the pig's meal consumption per 1 lb. live weight increase by ·16 lb. (33 lb. of meal for a 200 lb. pig). The pigs on restricted feeding took longer to reach the factory, but on killing they produced a higher percentage of good grade pigs, because of the thinner back fat. Fishwick in his experiment at Wye restricted his feeding to 5½ lb. per head per day at 200 lb. whereas the unrestricted pigs ate 7 lb. per head per day. It is advisable to allow the pigs all the food they will eat until they are 100 lb. in weight and to begin restrictions, if any, after that stage. If there is an acute shortage of building accommodation unrestricted feeding will ensure that the pigs reach the factory 2–4 weeks earlier than those which are on restricted rations. It will be noted that the meal consumption Tab. XXI p. 686 is restricted for pork and bacon pigs after 100 lb. in weight has been reached. Unrestricted rations would be ½–1 lb. greater daily (½ lb. at 110 lb. live weight rising to 1 lb. at 200 lb. live weight).

Baskett, Hale and Gray working in N. Ireland found that when pigs were allowed unrestricted dry feeding they gained in weight more quickly than when normally fed with a restricted wet ration. This was not so economical however, and the meal consumption per lb. live weight increase was greater in the case of the dry fed pigs and when they reached the factory dry fed pigs graded lower on an average than the restricted pigs.

The Use of Green Food. In normal times green foods are fed more for the health of the pigs than for the feeding value obtained from their consumption. During the war when foreign supplies of food were to a large extent cut off, green foods had to be used in much larger quantities to supplement the reduced meal ration.

Grass.

Grass is the most satisfactory green food, but clover leys, lucerne leys, kale, cabbages and oats and tares are all very useful if properly used.

The Use of Roots. Mangels, turnips and swedes are not very desirable foods for fattening pigs, though they are eaten by them and are quite harmless. Mangels or swedes are very useful for sows between Christmas and the start of the grass season. Potatoes are commonly fed and although pigs will eat them raw they give much more satisfactory results when cooked.

Collected Daily.

The Use of Swill. The term 'swill' means scraps of human food and the waste parts of vegetables collected for pig feeding. Swill has become an item of major importance since 1939 and it is true to say that our low pig population and our low home production of pig meat would now be lower still were it not for the amount of swill used in pig feeding. Any Housekeeper knows that, even where the greatest care is exercised, some scraps of food cannot be consumed by the household and these have frequently been used in the feeding of rabbits and poultry. The pig keeper's difficulty has been in the collection of adequate quantities of swill and it is

usually only economical for a commercial pig keeper to collect from restaurants, hotels or military camps where a quantity of swill is available at one point. The swill is collected daily and it must be cooked before feeding to the pigs to prevent the possible carrying of disease to the pigs; this is compulsory by law. The co-operation of the producers of the swill is invaluable, because certain items commonly found in swill are bad for the pigs. An excess of salt or soda, any rhubarb leaves, citrus peel and any putrefying foods or fermenting fruits should not be included. Foreign bodies such as razor blades, pieces of metal, broken glass and crockery usually sink to the bottom of the cooking container and can be collected before the swill is fed.

There are two forms of swill (1) untreated or raw swill, (2) concentrated swill or Tottenham pudding.

The untreated swill must under a Ministry of Agriculture order, be boiled or steamed for at least one hour and to get the whole mass properly cooked takes longer. The swill is allowed to cool and the fat may then be skimmed off and can be reheated, run into containers and sold. The peace-time price of this fat was 20/– to 40/– per cwt. and it was sold to soap manufacturers. The amount of fat from war-time swill was extremely small. The surplus liquid may be used for subsequent cookings. The remainder is the swill which is fed. Any bones found at the bottom of the swill may be cleaned and sold.

Cereal meal is added to the finished product to make it a suitable consistency for pigs to eat. 3½ lb. of raw swill are considered to replace 1 lb. of pig meal. Swill should only be fed in very small quantities to pigs under 50 lb. live weight.

Concentrated Swill.

Concentrated swill is sold in bags, having been sterilized by the local authorities which collect and process it. It is coupon free, keeps for about a fortnight and was sold for £4 10s. 0d. per ton during the war, as compared with 30/– per ton for raw swill. 2¾ lb. of concentrated swill replace 1 lb. of meal.

Tottenham.

The idea of producing this kind of pig food originated at a Workmen's Pig Club in Tottenham in 1940. The kitchen waste is placed in a steam jacketed container which holds about 2 tons of food. Revolving beaters keep the material stirred for about 2 hours. 1½ tons of raw kitchen waste produce about 1 ton of the concentrated product, the moisture content of which is about 65 per cent. The resulting 'pudding,' sold in non-returnable hessian sacks, in weights of 1 cwt., is easily transportable and easy to handle.

A much smoother pudding is produced by passing the material through a pulverizer before cooking; another refinement is a magnetic metal

The above types of concentrated kitchen waste can be fed alone as one meal of the day, the remaining meal consisting of a mixed meal ration. The pudding may be fed on the grass, whence it is cleared up readily by the pigs.

Any tendency to constipation caused by cooked swill may be corrected by means of suitable constituents in the meal part of the ration. Young pigs will soon start to eat concentrated kitchen waste, but it is not desirable to feed much to them until they are about sixteen weeks old.

It is hoped that with the return of normal conditions this valuable asset in the nation's balance sheet will not disappear and that local authorities will continue to find relief for their ratepayers from the sale of concentrated swill.

Feeding Stuffs.

Foods Rich in Digestible Carbohydrates and of Low Fibre Content.

Highly Digestible.

Barley Meal is produced by grinding barley which is not of sufficiently high quality for sale for brewing. This barley may consist of the smaller grain removed in threshing from a brewing sample or it may consist of the produce of some variety of barley sown especially for feeding. Such meal is included in normal times in almost every pig ration in quantities ranging from 45 per cent for breeding stock and for weaners, to 80 per cent for fattening pigs in their later stages of fattening. It is highly digestible, being comparatively low in fibre and produces a firm, white fat so desirable in a bacon carcase.

Finely Ground.

Maize Meal. When price permits this meal may be used up to 20 per cent of the ration of breeding or fattening stock. If used in excess of this amount in an unbalanced ration to fattening stock, soft, yellow fat may be produced and this reduces the value of the carcase. In order to obtain maximum feeding value from this meal, it should be as finely ground as possible.

High Oil Content.

Maize Germ Meal. The high oil content of this meal makes it unsuitable for fattening pigs, but it may be used up to 20 per cent of the ration of sows and young pigs, price and circumstances permitting.

Readily Eaten.

Flaked Maize. Unlike Maize Meal, this produces no adverse effect on the texture or colour of the fat. It may be used up to a third of the ration and is readily eaten by stock. It is particularly recommended for suckling sows and young pigs. Owing to its flaky nature it improves the texture of a ration and prevents it becoming

Should be Coarse.

Wheat Meal. This is ground Whole Wheat and when available may be used up to 30 per cent of the ration. If used too liberally it makes the ration sticky when it is mixed with water, and so may cause indigestion. It should be ground as coarsely as possible. The vitamin content, owing to the inclusion of the wheat germ, is higher than is the case with weatings.

Samples Differ.

Tapioca Meal has given results equal to those of Maize Meal, when due allowance was made for its poverty in protein. Samples differ considerably, but may be used to form up to 20 per cent of the ration.

Too Oily.

Rice Meal. This is high in oil content and would, if used in large quantities produce too oily a carcase. It may be used to replace about 25 per cent of the Barley Meal in a ration, but should be omitted from the ration of a bacon pig for safety.

Potatoes. There are usually the small or chat potatoes sorted out of the potato crop before sale. They may be fed raw if no method of processing or cooking exists, but this is not an economical way of using them. Potatoes which have turned green through exposure to light should not be fed raw. It is possible to feed pigs entirely on steamed potatoes, but experiments show that the live weight gain on this ration is not as satisfactory as on a meal and potato ration. The most satisfactory way of using up potatoes is to replace up to half of the meal ration with potatoes, allowing 4 lb. of unsteamed potatoes as the equivalent of 1 lb. of Barley Meal. If possible the potatoes should not be fed to any pigs under 4 months old because of the very much increased bulk of a ration including potatoes. In view of the very low protein content of potatoes, they must be balanced by some food having a high protein content. The liquid remaining in the potatoes after steaming or boiling should be discarded. Rations for older pigs may include as much as 8 lb. (uncooked weight) of potatoes in their rations; they should always be steamed or boiled. As a rule a slower rate of weight increase may be expected when potatoes are fed, but owing to the cheapness of chat potatoes the increase may be a more economical one than would be obtained from meal.

Ensiling.

Potatoes can be preserved in silos. Black reports ensiling 100 tons of potatoes, which were beginning to sprout. The only way of preserving them for use was to steam them and ensile them; this was done and by working overtime 8–9 tons per day were dealt with. Black describes in the same report the apparatus used for steaming up to 5 tons of potatoes per day and the method of conveyance of cooked potatoes to the pig shed.

Potato silage has been widely used on the Continent and in Germany a travelling cooking outfit moved round a given area cooking surplus potatoes on the farms. The potatoes should be ensiled as soon as possible after lifting before any damage or slight blighted tubers have a chance to decay. If the crop is very dirty it is advisable to wash it. The potatoes are cooked sufficiently to enable them to pack tightly into the silo and they should not be 'mushy.' They may be ensiled in brick or wooden silos above or below ground; old metal tanks may be used or the potatoes may be trodden into a pit dug on dry ground. Whatever they are put into, consideration should be given to ease of access to the silo in the winter months and proximity to the piggery. The potatoes must be rammed down tight or trodden down by a man with short boards strapped on to his boots. When the silo is emptied a large surface of potatoes should not be exposed, otherwise mould will cause wastage.

Variety of Names.

Foods with a High Fibre Content.

Wheat By-Products. These are the parts of the whole wheat which are removed when bread flour is taken from the wheat grain. During the war when over 80 per cent of the wheat grain was included in the National Loaf, the amount of by-products available for pig feeding was comparatively small. These pig foods have been known by a variety of names—bran, pollards, middlings, sharps and thirds, but in recent years these materials have been marketed in the following standard grades:—

1. Bran is the outside skin of the wheat grain and contains more than 5·75 per cent of fibre.
2. Weatings, which contain less than 5·75 per cent of fibre, are produced from home-milled wheat.
3. Superfine Weatings, which contain less than 4·5 per cent fibre. Since 1939 only two grades have been marketed, namely bran and wheatfeed.

Bran is used for pigs only when a mild laxative is needed; it is too fibrous to be included as part of a normal ration, because the digestive system of the pig cannot deal with it efficiently. Weatings may be used up to 75 per cent of a ration and are particularly suitable for breeding and store pigs. For fattening pigs the proportion of barley meal is usually increased and the proportion of weatings decreased to 30–40.

Used in the North.

Ground Oats. Oats are generally considered too fibrous for pig feeding, but where circumstances require it, they can be used to replace a proportion of the Barley Meal. They are much more commonly used in the north where oats are grown in much larger quantities than barley

or wheat. They are much more suitable for older pigs and should not be used in the early stages. Fineness of grinding is very important and Sussex ground oats or grain ground in a hammer mill are the most suitable, and for optimum growth may be used up to 30 per cent.

Brewers' Grains can be used as dried grains to replace part of the Weatings or as wet grains which should not be mixed with other foods until feeding time.

Sugar Beet Pulp. This food may be used as 20–25 per cent of the ration, provided that the ration is balanced to make up for the very low protein content of the pulp. The pulp is the dried residue of Sugar Beet after the sugar has been extracted. The pulp must be soaked for 8–12 hours before feeding.

Palm Kernel Cake Meal. This being rich in protein may be used as a vegetable protein supplement, and may be included up to 15 per cent in sow rations and to 10 per cent in fattening rations. It is deficient in minerals.

Foods Rich in Protein.

Fish Meal. If used in excessive quantities this meal may give a taint to the flesh of the bacon pig and may cause the cured bacon to keep badly. For these reasons it is customary to discontinue the fish meal during the latter part of the feeding period.

It is wise to select the best white fish meal for feeding and the oil content should not exceed 5 per cent. Under no circumstances should pork or bacon pigs receive fish meal during the last few days before killing, because the contents of the intestine are apt to taint the flesh through the boiling water in which the carcase is scalded. Up to 10 per cent of fish meal is included in pig rations, the actual quantity depending upon the composition of the other foods in the ration. There are other protein-rich foods which have given results as good as those of fish meal in experiments and these are described later in this section.

Fish meal is produced by drying and grinding surplus fish and fish offal, including a varying amount of bone. White fish meal is light brown in colour; it should be free from large pieces of bone and from offensive smell.

Meat Meal. This product varies much in composition, depending upon the proportion of bone and fat to pure meat. The meal is used as a substitute for fish meal, the amount included in the ration being 10–15 per cent according to the composition of the meal The most usual type of meat meal contains bone, which though it reduces the protein content to 50–60 per cent, nevertheless furnishes phosphate of lime.

Bean and Pea Meal. When used to supply the same quantity of protein as the animal protein-rich foods (fish and meat meals) may be expected to give equal results. It is necessary, however, to add a mineral mixture. If used in excess of 20–25 per cent it may cause hardness of the cured meat in bacon pigs. These are the only protein rich foods which can be grown on the farm.

Maize Gluten Feed may be used as a vegetable protein substitute. The oil contained in it is not of a very desirable nature, so that not more than 10 per cent should be fed to sows or to other pigs. This food is poor in minerals.

Extracted Soya Bean Meal. Provided that minerals are added to this meal and the amount of protein fed is the same, with growing pigs this meal will give results which compare favourably with those of Fish Meal. If required, both Extracted Soya Bean Meal and Fish Meal can be included in the ration. Soya Bean Meal contains little oil and should not be confused with Soya-cake Meal which contains much more oil of a rather laxtive nature.

Whale Meal may be used for the same purpose as fish meal. It is prepared from the residues of whale, after removal of the blubber. Owing to its high per centage of oil it should be used with caution in bacon production. Minerals should be added.

Dried Blood. This meal may contain as much as 85 per cent of protein and should not be used in excess of 5 per cent of the ration.

Dried Yeast. A vegetable product of varying protein content, usually about 45 per cent. A guarantee of its composition should be obtained. A small quantity of minerals should be added.

Decorticated Groundnut Meal. This may be either decorticated groundnut cake meal or decorticated groundnut extracted meal; the latter is preferable, though the oil is not so detrimental as soya bean oil. Undecorticated meals should not be used because of their much higher fibre content. Minerals should be added.

Milk By-Products.

Separated Milk. This is a protein supplement of the highest order and its use up to ¾ gallon per day for fattening pigs renders other protein-rich foods unnecessary. Suckling sows may receive 1½ gallons per day. With a limited supply the separated milk should go to the young pigs. Separated milk should be fed slightly sour; this corrects the somewhat constipating action of fresh separated milk.

Whey. This is not a protein substitute, for protein is removed from whole milk in the form of cheese. Whey is starchy and if fed in large quantities to fattening pigs tends to make them too fat, unless supplemented by other suitable foods.

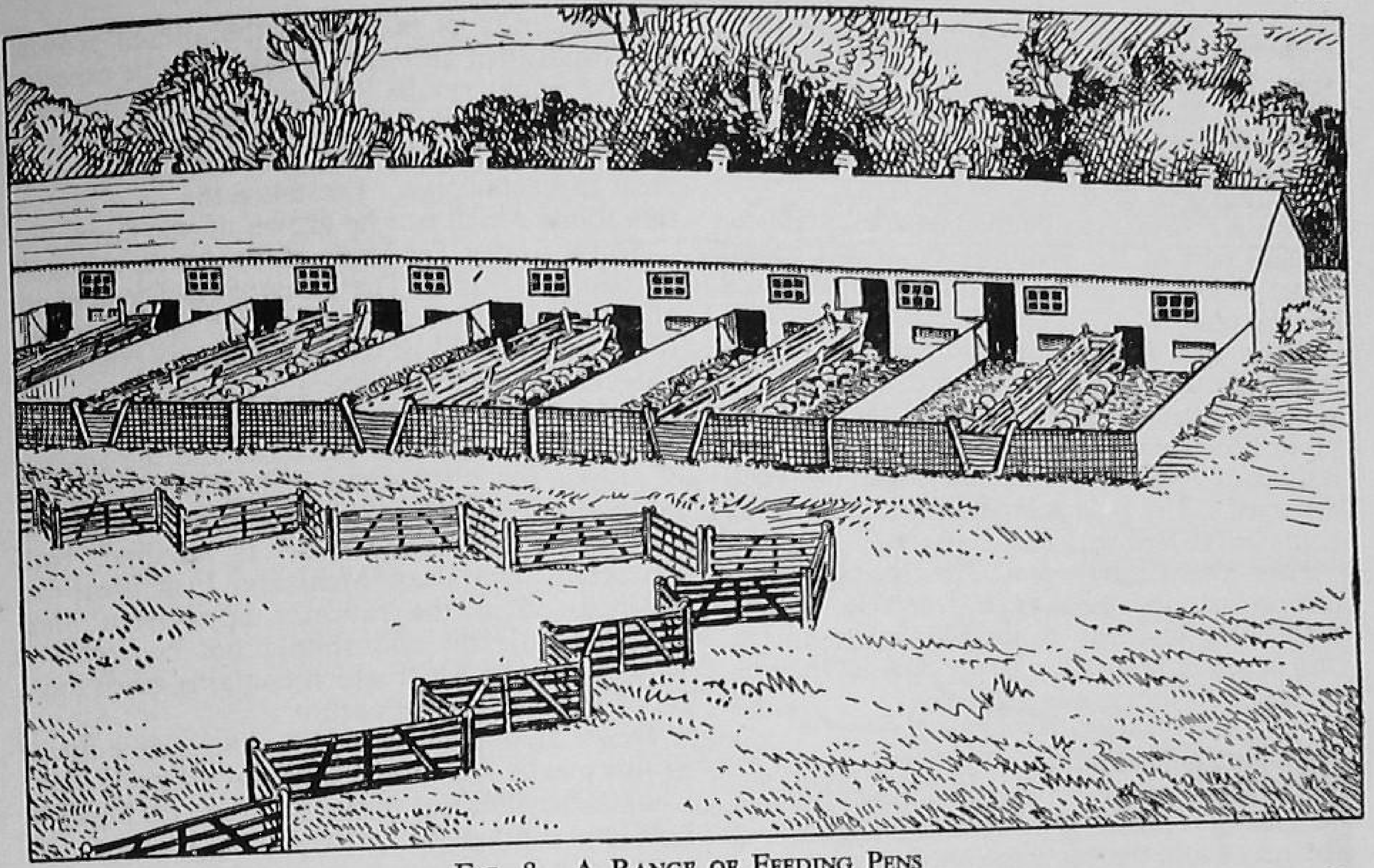


FIG. 8. A RANGE OF FEEDING PENS
(*Drawn from a "Farmers' Weekly" Photograph*).

HOUSING

The general principles of pig housing are given. Pig houses for use on the outdoor system are described and their advantages and disadvantages are duly mentioned. The materials necessary for the construction of permanent pig buildings are discussed and the advantages and disadvantages of the various types of indoor or permanent accommodation are shown.

Adequate Housing.

SUCCESSFUL pig-keeping depends to a large extent on adequate housing. Little has been written on the housing of pigs until recently when the Ministry of Agriculture published its 1945 Report No 17 "Farm Buildings," but much can be learnt from observation of housing methods as one travels round the country. Such an important aspect of pig-keeping deserves careful consideration and it will be dealt with here at some length.

The pig is naturally a clean animal and given adequate facilities it will not soil its bedding and in most cases will void in one corner of its house or run. The pig certainly pays for good housing and bedding since damp housing and shortage of bedding are conducive to the development of cramp, rheumatism and other ailments. Draughts too should be avoided. This does not necessarily imply very expensive housing, since the required conditions can be produced in comparatively cheap, temporary accommodation.

Out-door pig-keeping is suitable for all types and ages of pigs, both from the point of view of health and also from the point of view of food economy during the grazing months. The disadvantage of this system is the damage to pastures on all types of soil during the winter and on badly drained soils all the year round. Fattening pigs are usually housed indoors, because warmth and restricted exercise make the pigs fatten more quickly.

The prospective pig-keeper must decide first of all whether out-door pig-keeping is desirable and secondly how far existing buildings can be used for fattening or what fattening accommodation must be built.

Types of Building.

Different types of building are to be found on different farms; on some the buildings are old-fashioned and not very suitable, whilst on others there are modern buildings or excellent adaptations, which have been designed to meet the needs of the particular farm.

Conditions differ greatly from farm to farm and before erecting new structures or re-modelling old ones it is advisable to inspect the buildings which are in use on as many farms as possible to find out their merits and faults.

Because the pig has powerful biting jaws and strong neck and shoulders it can move considerable weights either in its mouth or with its snout. Buildings and fencing must, therefore, be constructed in such a way that the pigs cannot either pull them down or root them up.

All types of pig house should if possible face south, but a central feed house is best sited to run

north and south so that the actual pens face either east or west. If permanent buildings are being erected, the owner should consider the possibility of alternate uses for them. The old-fashioned sty with its low door, low roof and lack of light is quite unsuitable either for other types of stock or as storage accommodation. If the owner for some reason or another finds it necessary to cut down his number of pigs, he may find their sties invaluable for other uses, provided that they have been constructed with this point in mind.

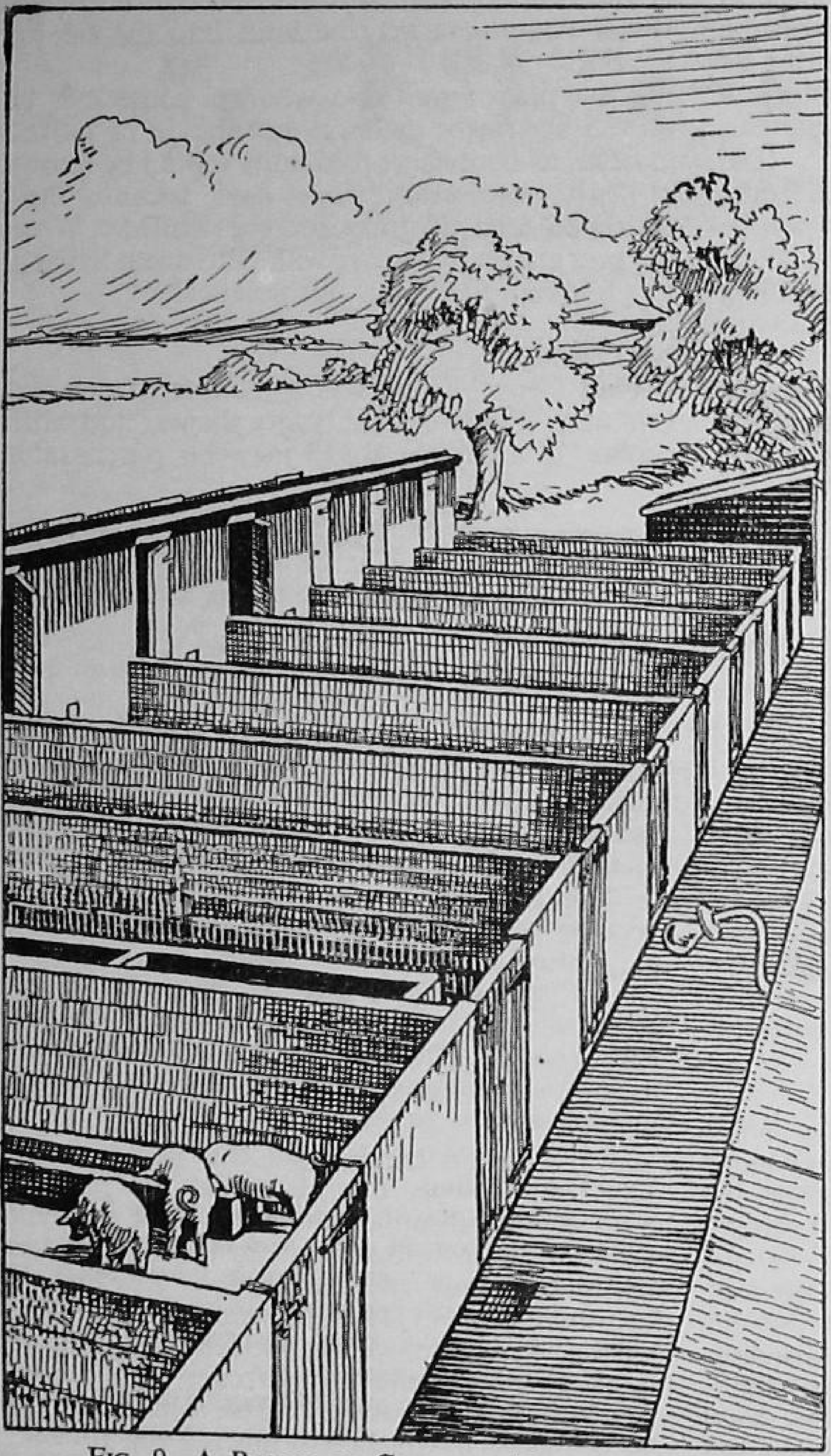


FIG. 9. A RANGE OF CONCRETE FARROWING HOUSES

(*From a photograph in a Cement and Concrete Association Publication*).

Should be Dry.

The situation of all pig buildings should be dry and under no circumstances must the earth level outside be touching the walls above floor level inside on any side of the building; otherwise the walls will be damp and there will be cramp or rheumatism among pigs. All sites must be efficiently drained.

In the following descriptions detached houses in grass fields or woods are referred to as out-door houses and sties or pens which are part of a permanent set of buildings are referred to as indoor houses.

Precautions Required.

Outdoor Pig Buildings. A dry bed must be provided and there must also be protection against draughts and sun. Permanent wooden sties, similar to those described in the indoor building section, may be erected in suitable woods or pasture fields, but this defeats one of the objects of outdoor pig-keeping which is frequent movement on to fresh ground. The remaining alternatives are as follows:—

Wooden huts on runners or wheels.
Pig Arks (Apex Huts).
Fold units.
Shelters made from straw bales.
Shelters made from thatched hurdles and straw stuffed wire.

Sectional Wooden Huts. In normal times a large selection of these huts is on the market and the prospective purchaser can choose a model to suit his requirements of design and price; one of the best opportunities of studying the various alternatives occurs annually at the Royal Agricultural Society's show or at the County Agricultural shows, when most manufacturers have their models on view.

Selecting.

The overall dimensions of these huts depends upon whether the hut is for the use of pigs only or whether the owner contemplates using it for alternative purposes, for example, for pigs and as a store. The roof is always sloping, so that the rain runs off and in order to use less timber for the back of the hut. The height of the front and back of the hut, when used for pigs only may be as low as 4′ 6″ and 3′ 6″ respectively, but 6′ and 4′ 6″ are more practical measurements, enabling the hut to be used for storage purposes if required. The floor dimensions of the hut should be 9′ × 6′. The floor is of wood and

should have slats running lengthways to prevent the pigs slipping if the wood floor becomes wet near the door. The doorway should be 2′ 6″ wide and the door should be in two halves so that either the top half or the bottom half or both halves can be opened. The two runners run the length of the hut, so that when a tractor is attached to the two hooks on the end of the runners the hut is moved sideways, presenting its narrowest width to gateways or any other narrow spaces that have to be passed. Such huts can be moved down roads for short distances. The door may be in one end of the hut or at the front; in one end of the hut is a trapdoor which can be opened for inspection by the pigman; an alternative type of inspection door may be a sliding panel. The wooden roof should be covered with good quality roof felting, which should be dressed with tar or some bituminous substance as often as necessary; treated in this way the life of felting may be 10 years or more. The whole hut must be strongly constructed or it will soon collapse under the strain of moving. Timber should be creosoted under pressure before building starts and the walls should be made of either weather boarding or grooved and tongued boarding.

A water trough may be built into the wall of the hut, but feeding troughs should be separate units as these are much more easily cleaned than built-in feeding troughs and the required number of troughs can be more easily provided for the number of pigs in the hut.

This type of hut is suitable for farrowing sows and for sows and litters, either with the sow tethered or running loose in a grass run. These huts can also be used for weaner pigs which may remain in them until they are 70–80 lb. in weight, at which time they will be moved to their fattening houses. If the sows are tethered no fencing is necessary, otherwise adequately fenced runs must be provided.

Pig Arks. These are also sectional wooden buildings, but because of their triangular form they have been placed by the author in a separate section. The height at the apex of the triangle may be 6′; the floor dimensions may be 9′×6′. The narrow angle formed by the walls and the wooden floor, if there is one, provide adequate protection for the young pigs from the sow and act in place of a farrowing rail, which should be provided in other types of sectional buildings and along the straight walls of arks. The arks are mounted on runners and can be more easily moved than the straight sided house discussed in the previous section. Less timber is required and consequently the house is cheaper to purchase or construct.

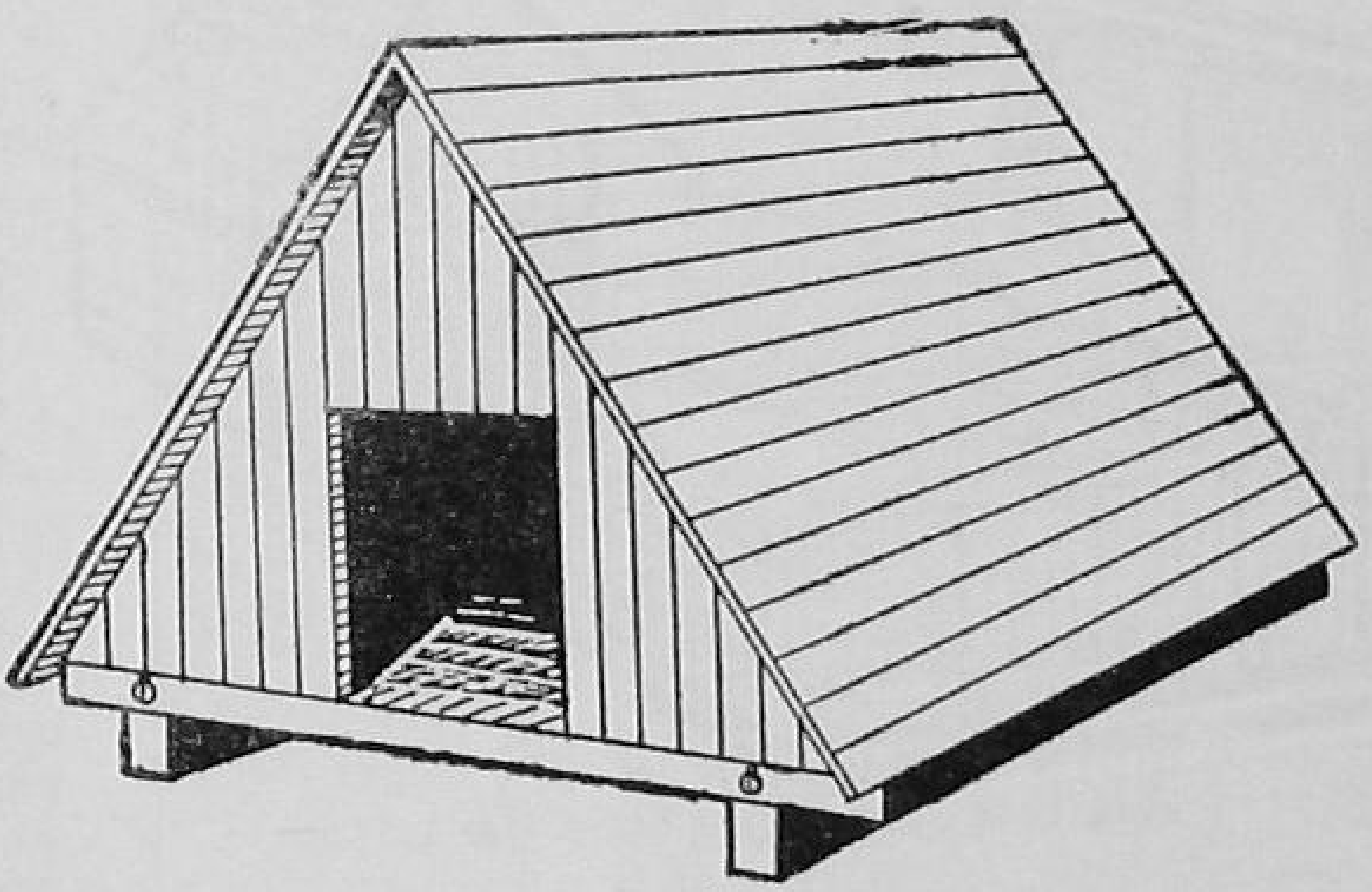
This type of house is suitable for tethered sows with litters, or for sows and litters on free range in wire runs. It can also be used for young pigs from the time of weaning until they are about 80 lb. live weight.

Trap doors or sliding panels should be provided in the walls of the ark for inspection purposes. Water containers may be built into the side of the hut.

All types of movable wooden house can be moved by tractor or horse and should be moved as often as necessary; fold units should be moved at least once every three days because their restricted area of grass becomes soiled. When the pigs are on free range with permanent fencing, this frequent moving is not practicable.

No Fencing.

Fold Units. There was a number of different fold units on the market before the war and when timber is available these may be purchasable



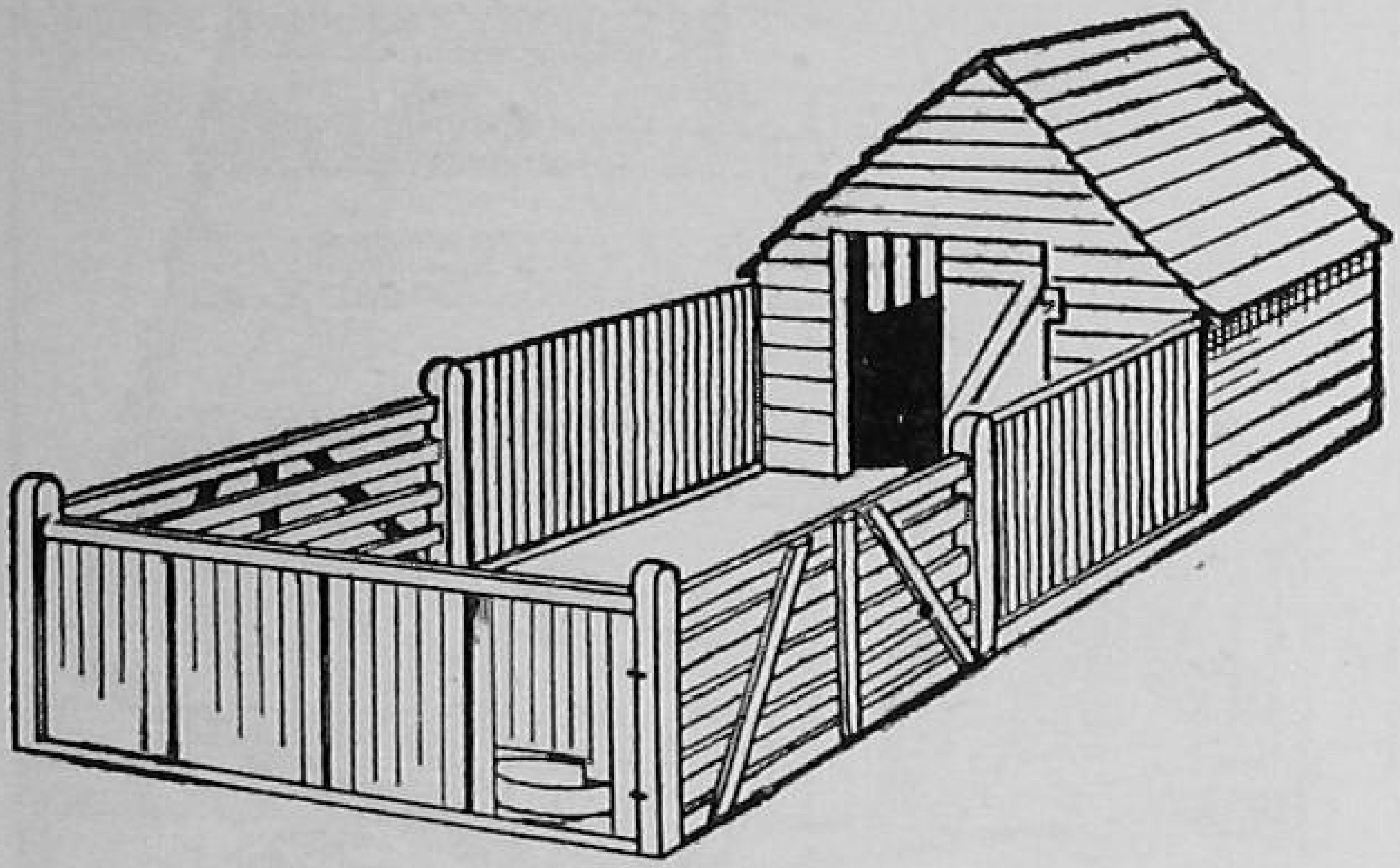
PIG-ARK

FIG. 10

again. A good handy man can make similar units if the owner considers that the job can be done more cheaply at home. One of this type of unit, the Trowbridge, made by the Pig Breeders Supply Company of Checkendon, Reading, is illustrated in Fig. 11. It consists of a weather boarding 8′ square, with a wooden floor, built-in farrowing rails, built-in dry feeder with a roof slide for filling and an adjustable window at the rear of the hut. Attached to this is a run 10′×8′, constructed of timber and corrugated galvanized iron sheets. The run can be extended to 19′ by the introduction of a timber hurdle into each side of the run, thus allowing more exercise and grazing room when the unit is used for weaned pigs, which require more grass than a sow and litter. The run when used with the solid sides provides good protection from wind. The feeding and watering can be carried out without entering the hut or run, a water trough being built-in to the end of the run. The outfit should

be moved on to fresh ground as often as necessary and if this is done at intervals of not more than 3 days it provides immunity from worm infestation; four acres allows 10 units to be moved daily for a year without using the same ground twice. The moving should be carried out by the use of a horse and it is a good thing if the size of the pig unit be so arranged that a horse is at its permanent disposal. On the completion of the distribution of meal the horse is taken from its cart and moves the houses. As troughs etc. are all attached to the unit there are no loose parts to move. No fencing is required. The disadvantage of the fold unit is the labour involved in the periodic move. The pre-war price of the Trowbridge unit was £11 10s. 0d., without the extending hurdles; at the time of writing the units can only be made if a timber licence can be obtained.

Fold units are suitable for boars, pregnant sows, sows and litters and store pigs from weaning until they are about 100 lb. live weight.



FOLD UNIT SUITABLE FOR SOWS AND LITTERS

FIG. 11

Adaptable.

The Use of Straw Shelters. All types of straw shelter are fixtures for whatever period they are required. They are not worth moving and re-erecting. On the other hand they can be made into satisfactory ranges of sties to take the place of permanent wooden, brick or concrete sties. Suitably erected in fact, they are more adaptable than any other type of outdoor shelter; they may be used for farrowing, for weaner pigs or (if well enough erected) for fattening.

Shelters of Straw Bales. These should not be used for long periods and when the pigs are moved to fresh ground the old hut should be burnt or the straw used for bedding cattle yards. They fulfilled a useful purpose during the war, when building material and skilled building labour were scarce; at the time of writing it does not appear likely that this state of affairs will improve for several years. In addition to this temporary state of affairs, the country finds itself in possession of increasing quantities of baled straw due to the mechanization of arable farming; it may well be that the straw bale building will become a permanent feature of our stock farming.

Straw bales may be used to form all the walls of a sty or they may be used to make a dividing wall in an open or a covered yard or to make wind proof sides for a temporarily empty Dutch barn. The risk of fire should be carefully considered. Fleas, which are frequent inhabitants of pig houses, may be troublesome; the remedy for this is to burn the shelter; the prevention is to spread D.D.T. dust under the bales.

Desirable Dimensions.

Straw bale shelters will probably last for longer than it is desirable to keep them on the same site. It is desirable that the lowest layer of bales should not rest directly on the ground, because the damp will quickly corrode the baling wires causing the lowest bales to burst. If possible hard core should be placed in a shallow trench under the wall of bales. A piggery consisting of two separate compartments each 8′ square, with an 8′ high front and a 4′ high back, with timber supports over the doorway and a roof of thatched hurdles, will require about 170 bales of straw and five man days to build it. Obviously, two men working together are necessary for the economical handling of the bales.

A small shelter suitable for a sow and litter may be made from about 25 bales, giving an inside measurement of about 6′×7′. Both the inside and the outside of straw bale huts must be wired with sheep netting to prevent the pigs pulling the bales to pieces. The standard size of a bale made by a stationary baler is 3′ × 2′ × 1′ 6″; those from a pick-up baler are slightly smaller. The thickness of walls should be either 3′ or 2′—not 1′ 6″ because this is too narrow a base for the bale to stand on.

Shelters made from Thatched Hurdles. These are satisfactory so long as the hurdles are well thatched and suitably protected by wire to prevent straw pulling by the pigs. The hurdles should be thatched with wheat straw.

Shelters made from Straw-Stuffed Wire. These may be made to any dimensions required All sides of the shelter consist of 2 thicknesses of fine mesh wire netting fixed to the supporting posts of the roof. Straw is tightly stuffed between the two thicknesses of wire which are joined at the

top and bottom, making a thick bolster of straw which is draught proof.

Indoor Pig Buildings. There are many types of indoor (or permanent) pig buildings and there are many materials from which floors, walls, roofs and runs can be constructed. It will be simpler to make any necessary comments on these materials before discussing the types of house.

Concrete is Often Used.

Floors. The outdoor pig house has either a wooden floor or none at all. The indoor pig house may have a floor of wood, concrete, bricks, asphalt, concrete slabs or chalk. Wooden floors are the warmest, but have a limited life because they are subject to rotting. Ordinary building bricks, at present unobtainable, are expensive and absorb too much urine or outside moisture. Asphalt is somewhat difficult to lay and unless very well laid allows the urine to permeate all its cracks. Concrete slabs are liable to be broken where hollows occur under the surface of the slabs. Chalk is too porous and absorbs too much moisture. There remains, until something better is produced, concrete.

Concrete is durable, easily cleaned, non-absorbent, not slippery (if rough finished), comparatively inexpensive, self-draining (if properly sloped), and it can be laid by ordinary farm labour. Concrete floors are cold if laid directly on the soil and, therefore, an air space should be provided underneath the concrete. This may consist of 3″ land drain pipes laid in rows on 2″ rough concrete and covered by 1½″ of fine concrete. Hollow building blocks may be used in place of the drain pipes. The same air space effect can be obtained by using corrugated sheets between flat sheets top and bottom; these are constructed of asbestos-cement mixture. They are non-slippery but are more expensive than the drain pipes or hollow building blocks. The cheapest method of providing this air space is by laying the concrete floor on loosely packed rubble, broken brick, large flints or stones or any other broken material.

It is a common practice to use a portable wooden platform on top of the concrete floor; this is raised a few inches above the level of the concrete. Such a platform is difficult to clean, deteriorates rapidly and its use has been discontinued at Wye without any ill effects where the concrete floors have been well laid.

Roofs. These must be watertight and bad conductors of heat. From the point of view of the pigs' comfort, thatch is the most suitable, but it is impracticable except on buildings already described in the 'outdoor' section. For permanent use it is too liable to harbour vermin, though this difficulty can be partially overcome by the use of wire-netting.

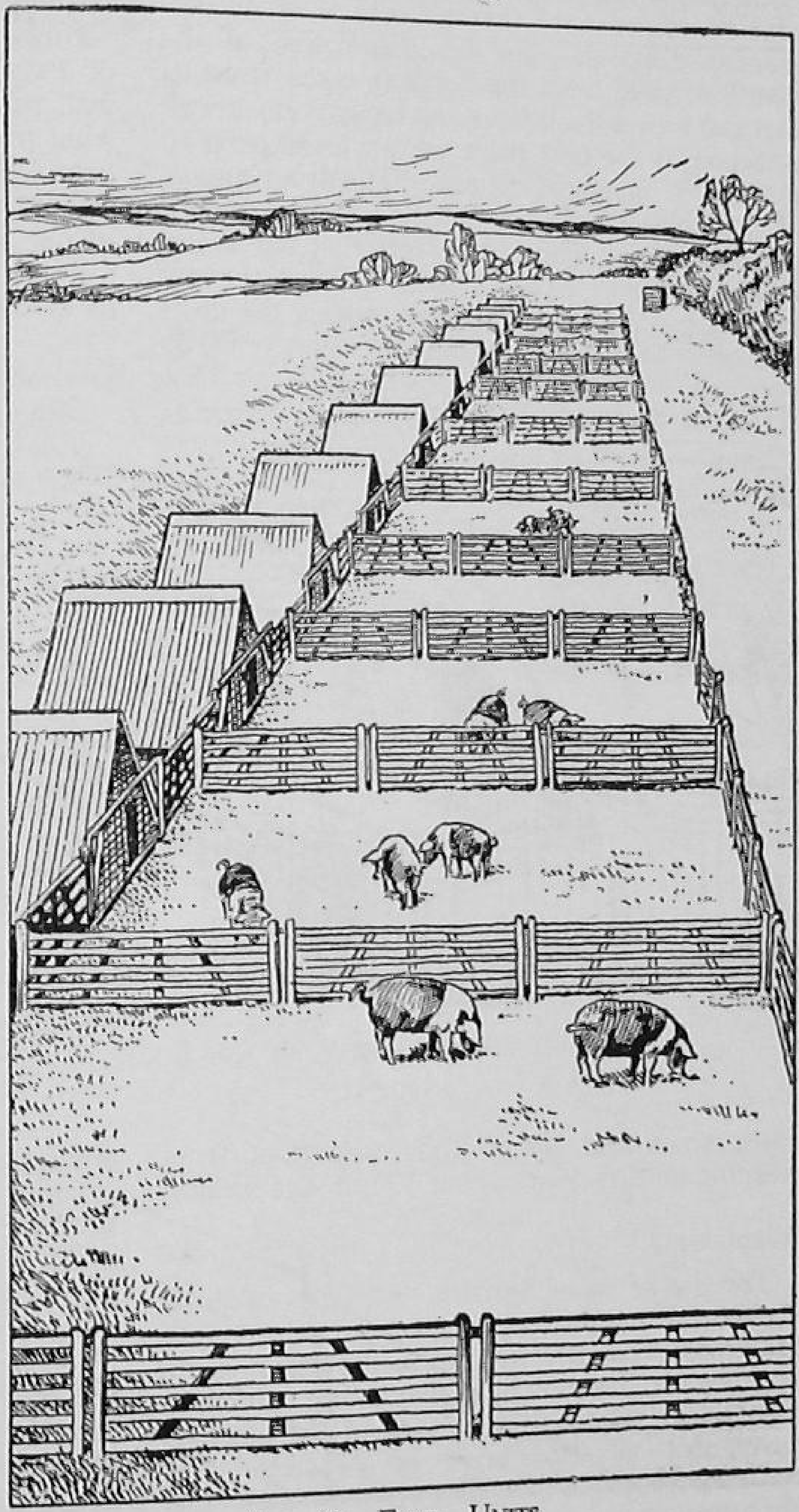


FIG. 12. FOLD UNITS
(*From a "Farmers' Weekly" Photograph*).

Various Materials.

Pig roofs are normally constructed of wooden boards or of corrugated iron or asbestos sheeting. A boarded roof must be covered by properly laid roof felting, which will last, if treated occasionally with some bituminous dressing, for 10–15 years. Corrugated iron is very hot in summer and very cold in winter and it is desirable to obviate these

disadvantages by an inner roof of light timber. Asbestos sheeting does not permit the same extremes of temperature, but it is brittle and should not be used on a building which may have to be moved.

Walls. The brick-built piggeries of 20 or 30 years ago are not being constructed to-day; their cost is high and the existing shortage of bricks and housing is likely to last for many years; moreover a brick wall is comparatively difficult to clean.

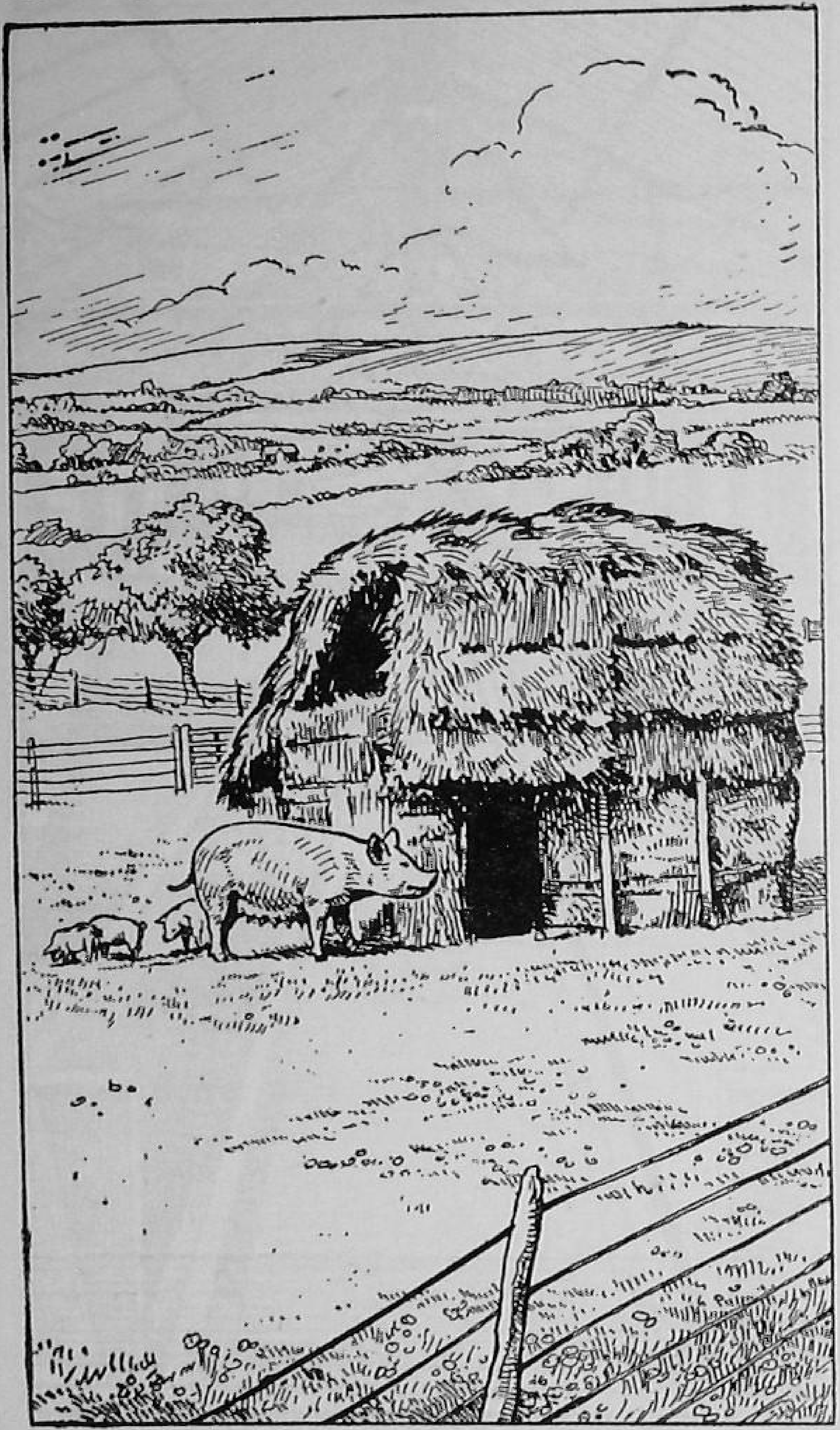


Fig. 13—Straw Bale Hut

Hollow concrete blocks may be purchased or made on the farm. A convenient size for them is 16″ × 8″ × 8″ (including the mortar) so that the laying of them is much quicker than in the case of bricks and the cavity in the blocks acts as an insulator and helps to prevent damp. The same object may be achieved by making narrower solid blocks into a double wall with a space between. Concrete blocks should be made at least a month before they are required unless rapid hardening cement is used. If the blocks are made of a very porous mixture by using a small proportion of cement, the outside surface exposed to the weather and the bottom 3′ of inside walls should be cement rendered with a mixture of 1 part cement to 3 parts coarse sand; this facilitates cleaning and renders the walls weatherproof. The angle between the wall and the floor of both the inside of the sty and the outside run may be rounded off.

Wooden Walls are Good.

With unskilled labour wooden walls may be more easily erected and they are cheaper and warmer than brick or concrete. They are, however, less durable, absorb moisture more readily, are more difficult to clean withou using water and moreover they require more maintenance. Wood is the cheapest form of sty wall, but it is best to have all the wood creosoted under pressure. The framework of the walls must be strong, the corner posts being not less than 4″ × 4″ and the rails not less than 3″ × 2″. The external covering of this framework may be weather boarding or vertical boards with cover fillets over the joints. There should be a lining to a height of at least 3′ and this may consist of corrugated iron or of elm boarding 1¼″ thick and presenting a flush face so that there are no cracks or ledges on which dirt can accumulate and which the pigs can start to chew. The outside run and the door should have the framework outside so that a smooth boarded surface is presented on the pigs' side of the wall; this is easier to clean, more difficult to gnaw and the weight of the pig against the wall does not force the boards off the frame.

Partition walls in a range of sties need not be more than 4′ high, but if the range is a long one some of them may be built up to the roof to assist in the prevention of draughts.

All doors in pig buildings should have latches at the top and bottom.

The above remarks on materials for floors, roofs and walls apply to any type of pig accommodation; the following paragraphs describe the construction, dimensions, advantages and disadvantages of different types of pig accommodation.

Indoor or permanent piggeries may consist of any of the following:—

1. Existing open or covered yards which are part of a farmstead.
2. Loose boxes, disused cowsheds, disused horse stables on other parts of a farmstead.
3. Ranges of sties with run or courtyards attached.
4. Central feeding houses of the Scandinavian type.

The General Farm.

1. *Open or Covered Yards.* One or both of these buildings nearly always form a part of an old set of farm buildings. They may be satisfactorily used for pig-keeping without any major structural alteration, though divisions made of straw bales or wire stuffed with straw may be built to provide warmth, reduce draught and enable the large floor area to be sub-divided into smaller units so that the pigs can be divided into small groups according to their size, rations, etc. On the general farm straw is available in large quantities and this can be turned into dung by the voiding and treading of the pigs. Pigs may share a covered or open yard with cattle, but a corner should be fenced off so that the pigs may feed and sleep away from the cattle.

2. *Loose Boxes.* These boxes frequently open into a covered or open yard, and, provided that the floor is higher than the manure level in the yard, they are quite satisfactory for in-pig sows or for sows and litters. The boxes drain into the yard and manure is thrown out into the yard. Loose boxes which open into the outside air are not entirely satisfactory for pigs because it is difficult to get adequate ventilation without getting a draught on every part of the floor with nowhere warm for the occupants to sleep.

Useful Buildings.

Disused Cowsheds and Horse Stables. The movable milking bale has caused a number of farmers to run their dairy cattle out of doors both winter and summer and to milk them in the field in a movable milking shed or bale. The cattle are turned into permanent covered or open yards or into temporary straw bale yards if they are housed at all. The cowshed on these farms is, therefore, unemployed and may be converted into a pig fattening house of the Scandinavian type (to be dealt with later). Mechanization has caused many farms to be without horses; the horse stables may have been converted into tractor garages or repair shops or they may be converted into pig fattening quarters after suitable modification.

3. *Sties with Courtyards or Runs.* A single sty on this pattern may be erected for the use of cottagers or a range of sties 10 or more in number may be required. The range should not be too long, because of the time needed to carry food and manure along the range. Sties of this type are the most satisfactory accommodation for indoor farrowing sows and can equally well be used for fattening pigs. The inner compartment must be reasonably warm for sleeping and to provide shade from the sun. The outer compartment, known as the courtyard or run, provides

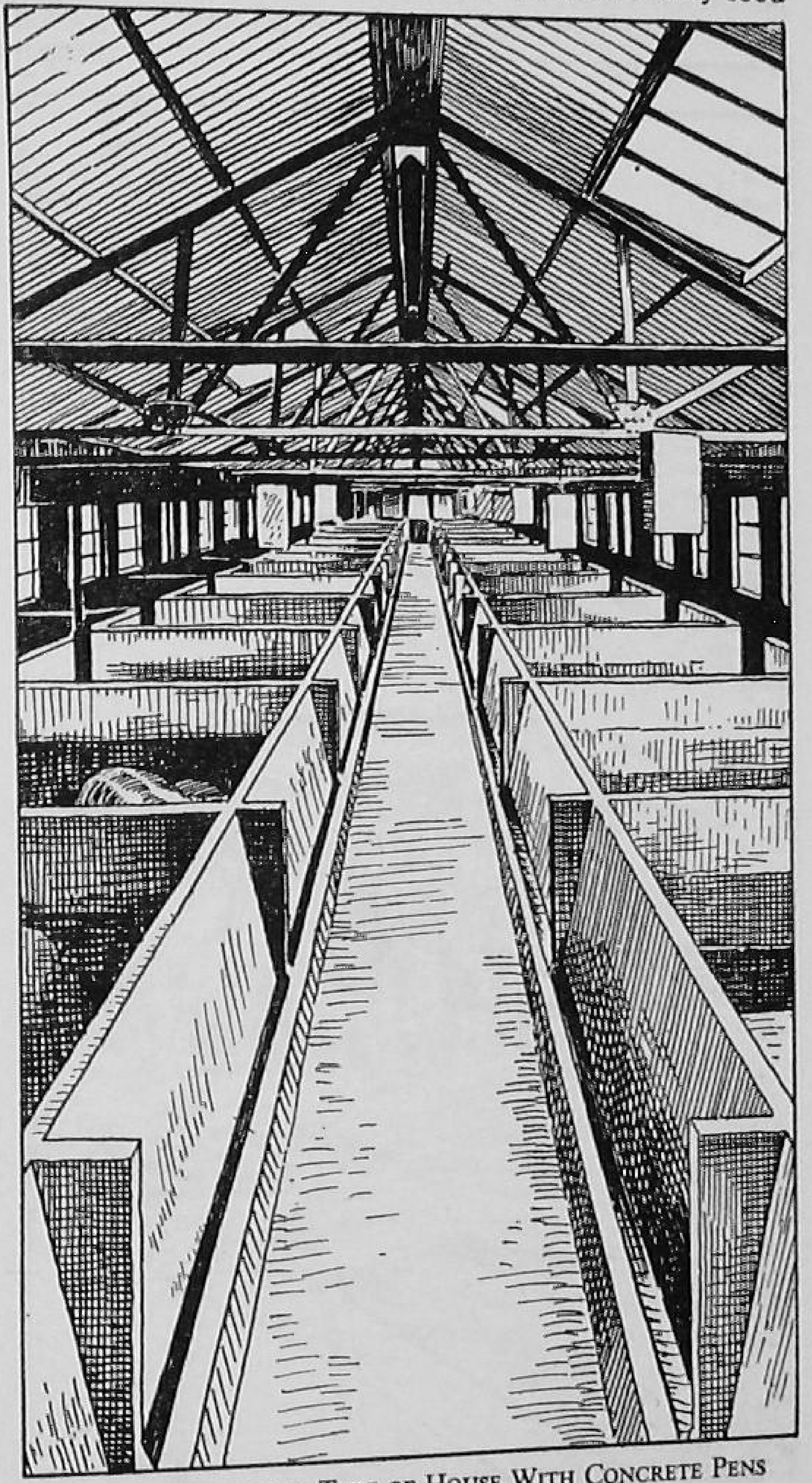


Fig. 14. Scandinavian Type of House With Concrete Pens *(From a photograph in a Cement and Concrete Associated Publication).*

exercising space in the unfiltered sunlight and is usually selected by the pigs as a voiding place. Ranges of sties of this type can be erected by farm labour if necessary, whereas the Scandinavian type house, owing to its more complicated roof, can only be erected by qualified builders. At the present time timber and materials are not available for any building and the cost of such an enterprise is prohibitive.

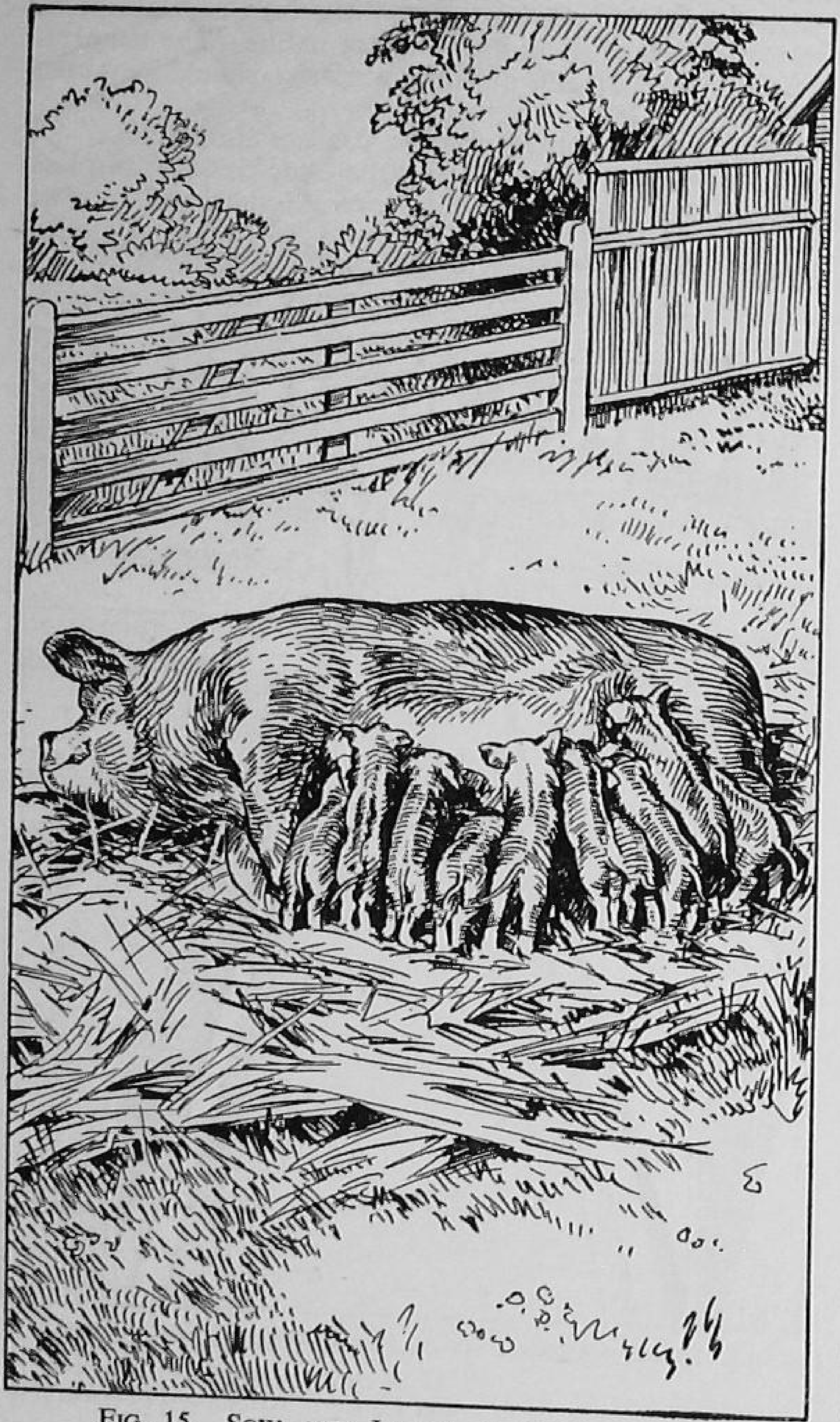


FIG. 15. SOW AND LITTER IN OUTDOOR RUN

A Type Satisfactory.

It is an advantage if the courtyard can be completely enclosed in severe weather and this has been provided for in the Wye farrowing house (V. C. Fishwick, 1944), a type of house that has proved very satisfactory; the sties are arranged in pairs, each consisting of a sleeping compartment and a covered yard; the door leading into th sleeping compartment is situated diagonal opposite the door entering the yard. Swin shutters can partially or completely close the fron of the yard, thus preventing driving rain fron entering the yard and helping to warm th sleeping compartment. Swing shutters can b opened in hot weather in the front of the sleepin compartment, but these are normally closed An air space along the top of the st just below the roof provides ventila tion. A small creep across one corne of the sleeping compartment enable young pigs to be fed, or dosed with medicines away from the sow Farrowing rails may or may not b fitted. The building is 7′ 3″ high in front and 3′ 3″ at the back, both compartments being 8′ square. These are suitable dimensions for sows and litters. If the range is being built for fattening pigs the sleeping compartment and the yards should be made 12′ wide and 6′ deep, a swing shutter trough 9′ long being fitted into the front wall; such a pen will hold 8 bacon pigs.

There are many designs for similar ranges of sties and it is not possible to describe here more than the one above.

Advantages.

4. *Central Feeding or Scandinavian Type Houses.* This consists of two ranges of pens under one roof with a central feeding passage and dung passages at either side. The original Scandinavian house was designed to cope with a much more rigorous climate than ours, it usually had a fodder loft over it and the interior was heated with stoves. Frequently accommodation was provided for sows with litters, weaners, fattening pigs, meal store and a cooking copper all under one roof. The efforts at copying these houses in this country have not always been successful and some very bad ones are to be found. The failures have been caused chiefly by draughts, by bad ventilation, by the use of cold materials such as corrugated iron for the outside walls and by the laying of concrete floors not properly insulated from the earth. The advantages of this type of house, when it is properly constructed, are that the labour is reduced because the central feeding passage enables two rows of pigs to be fed almost as quickly as one row can be fed in outside sties and the dung passage enables sties to be cleaned out more quickly. Steam from the boiler house must not be allowed to pass into the sties. The dung

passages must be not less than 3′ 6″ across in order to allow the pigs room to turn round; the pen door when opened fastens across the dung passage, so that each pen has a length of dung passage in which the majority of the pigs will void their dung. All the doors should have fastenings at the top and bottom, all angles between floors and walls should be rounded and all walls in contact with the pigs should be cement rendered up to a height of 3′. The part of each pen where the pigs lie should be raised 3″ above the rest of the floor and both parts of the floor should have a fall of 1″ in 6′ towards the drain. Each pen must drain independently to the outside of the house and the liquid must not be allowed to flow along the dung passage, otherwise other pigs will be able to come into contact with it. Roof lighting is very effective and 50 sq. inches should be allowed per pig. Window lighting should be on the scale of 1 square foot per pig and the cubic capacity of the building 200–250 cu. feet per pig. On some modern piggeries erected just before the outbreak of the 1939–45 war air conditioning systems were installed instead of the natural ventilation. These proved to be most satisfactory and doubtless much progress will be made in this direction when normal building conditions return, because natural ventilation is dependent for its efficiency upon the human element as well as upon the forces of nature. The temperature of one of these piggeries should be about 70° F.

The central feeding passage should be 6′–7′, pens 8′ 6″ × 12′ and the dung passages not less than 3′ 6″; the total overall width will thus be 32′–33′. Pens of this size hold 10 pigs. Detailed plans of this type are shown in Bulletin No. 32 of the Ministry of Agriculture and Fisheries.

BREEDING STOCK

Our Author reviews the management of the breeding stock. There is a discussion on the selection, feeding, housing and mating of boars and sows, the care of the sow at farrowing and the subsequent rearing of the litter, the castration of surplus males, the weaning of the litter, the rearing of breeding gilts and their selection. The gestation period, oestrum, the age of mating, the length of the breeding life, prolificacy, and the marking of young pigs are considered.

The Basis of Success.

Management of the Sow. The efficient management of the breeding gilts and sows in a herd is the foundation on which pig production of any kind is built. The success of the pork pig, the bacon pig, the pedigree pig for breeding or the show pig depends initially on the management of the sow. The rearing of breeding stock is discussed in a later section and for the moment it must be assumed that breeding gilts or sows are available.

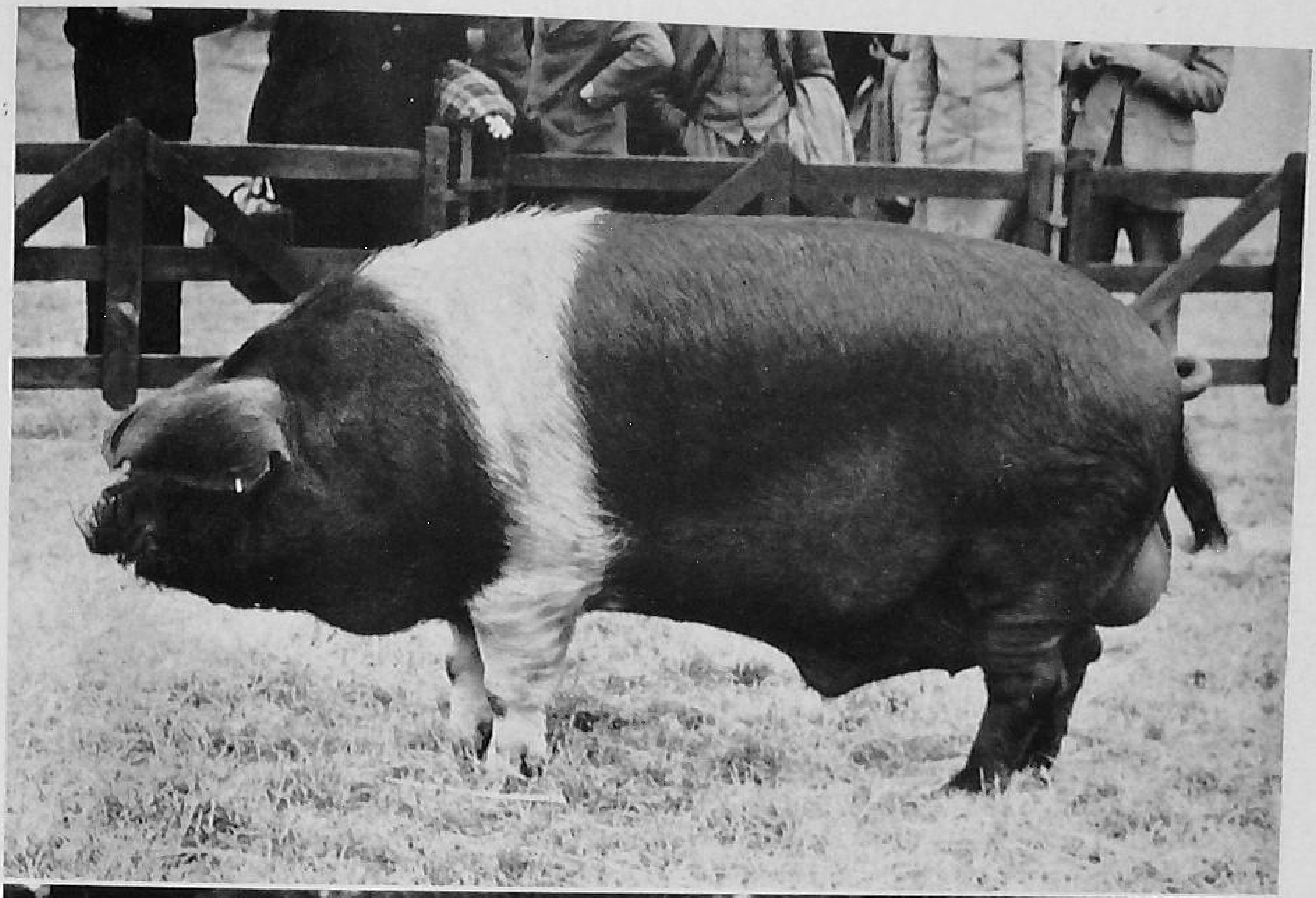
The gilts will have been separated from the boars at 6 months old, because at about that age they attain puberty and if the sexes are left together they may breed. It is not advisable to mate gilts prior to the age of eight months, because their growth will almost certainly be restricted and the resulting litters will be small and weak; the actual birth of the litter will be difficult and it is quite probable that the gilt will die. Gilts grow so rapidly at this age that it certainly pays to wait an additional two months and to mate them at eight months old. Many pedigree breeders, on the other hand, anxious to obtain greater size and development in their stock, often delay mating until the gilt is 12–14 months old. In a commercial herd the loss of these 4 months may be regarded as an unnecessary loss of time. There is an added danger in deferring mating until 12 months old and that is the tendency of the gilt at this age to lay on fat, which makes her less likely to conceive at the first service. Over-fatness in breeding stock of any age is a bad thing for the same reason and should always be avoided. The degree of development of the gilt at 8 months will obviously be different from farm to farm according to the liberality and suitability of the feeding, the composition of the ration and the general management, so one should not be too dogmatic about the mating at 8 months and a standard size for mating is a better guide than actual age. The season of the year during which the first litter will be born is another point to be borne in mind; the young gilt will have a much easier time with her first litter in the spring and summer and it might well pay the owner not to mate his gilts to farrow in mid-winter but to defer it for a few months. His decision on this matter will also be influenced by the type of house in which the gilt is to rear her pigs. The mother has her first heat period from 3–10 days after the young pigs are weaned, and it is a known fact that she is more likely to conceive if served during this heat period than during subsequent ones. Conception during this period ensures that two litters in a year will be produced and weaned by this sow.

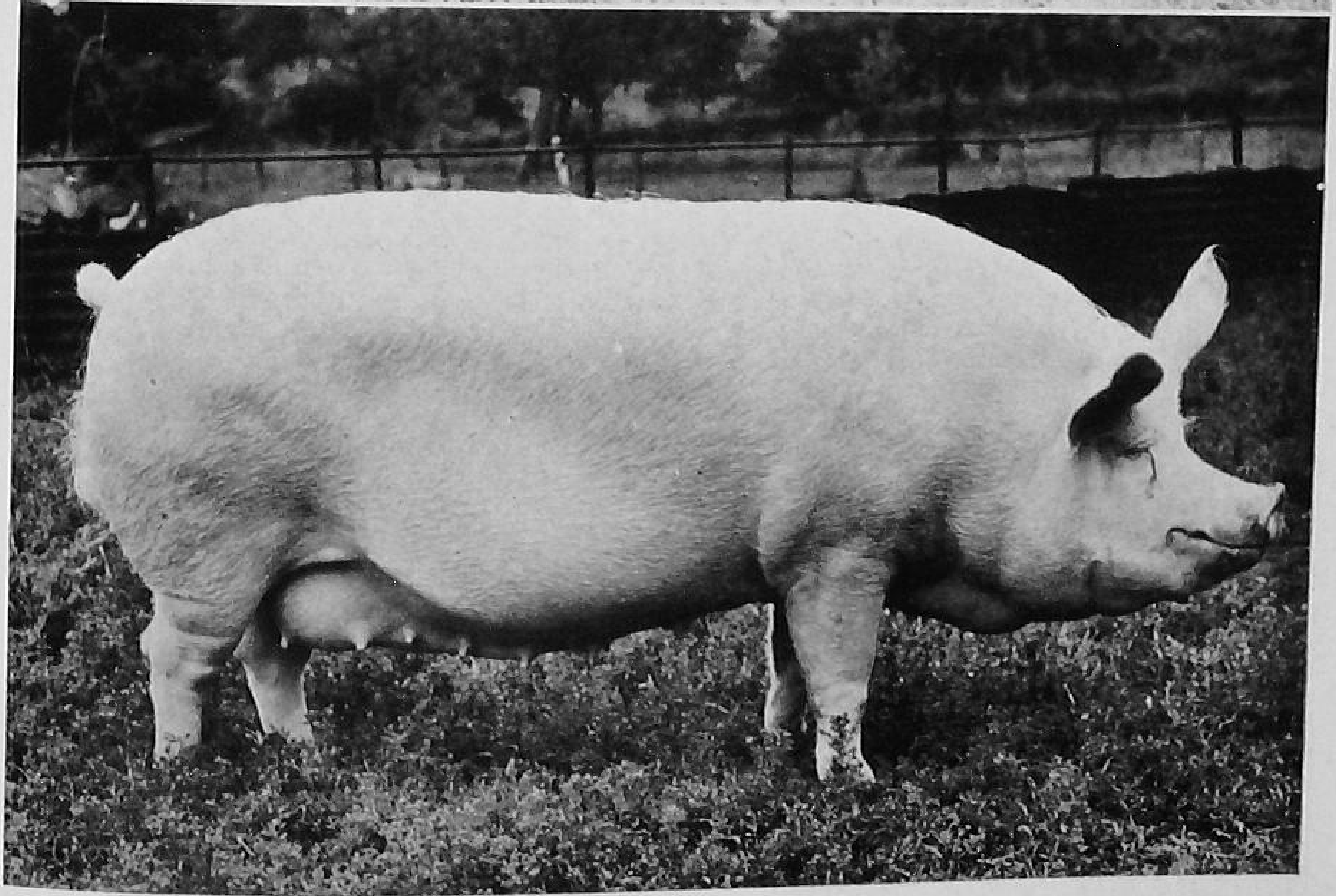
A sow that is being well-fed while rearing only a small litter may come on heat whilst she is still suckling the litter. If it is intended to breed from her again, in spite of her small litter, it is as well to mate her during this heat period, though she may not become pregnant.

The gestation period of the sow, which is 16 weeks (112 days), is subject to very little variation. Careful record should be kept of the expected farrowing dates; they are easily worked out from one of the many breeders' tables which are published. Old sows, gilts and sows in poor condition tend to farrow a day or two before their time is up, whilst strong, healthy sows in good condition tend to farrow a day or two beyond their time.

The breeding life of the sow, as with all other farm stock, is very variable. She may eat, fail to suckle or overlay her first litter, in which case she will not be retained for breeding any more unless she is a pedigree pig of a particularly valuable strain. She may become ill, she may be particularly bad tempered or she may not meet the owner's requirements for some other reason, but if all goes well she should breed 8–10 litters during her breeding life. Sows have been known to breed for 8–10 years, but the average life is about 6 litters. In countries or districts where the winter is very severe it is customary to breed only one litter a year and that, of course, is born in the spring. In this country the best months for the litters to be born are February and August, but in order to disperse labour, food consumption, housing and marketing it is customary to arrange for sows to farrow throughout the year, the poor pork market during the hot summer months being overcome either by selling some of the litters as weaners or running them through until they are of bacon weight. A pig of small pork weight on May 1 will reach bacon weight in just over 100 days—say August 1. In a good herd the average number of pigs produced by a sow at a birth is just over 9 and the number actually reared is 8, but this depends on a number of factors and it would perhaps be as well to enumerate the factors affecting this and discuss each one in turn.

1. High or low natural prolificacy of the strain of sows.
2. The proportion of gilts to sows.
3. Freedom from disease.
4. Good housing.
5. Good feeding.
6. Mating.
7. Farrowing.



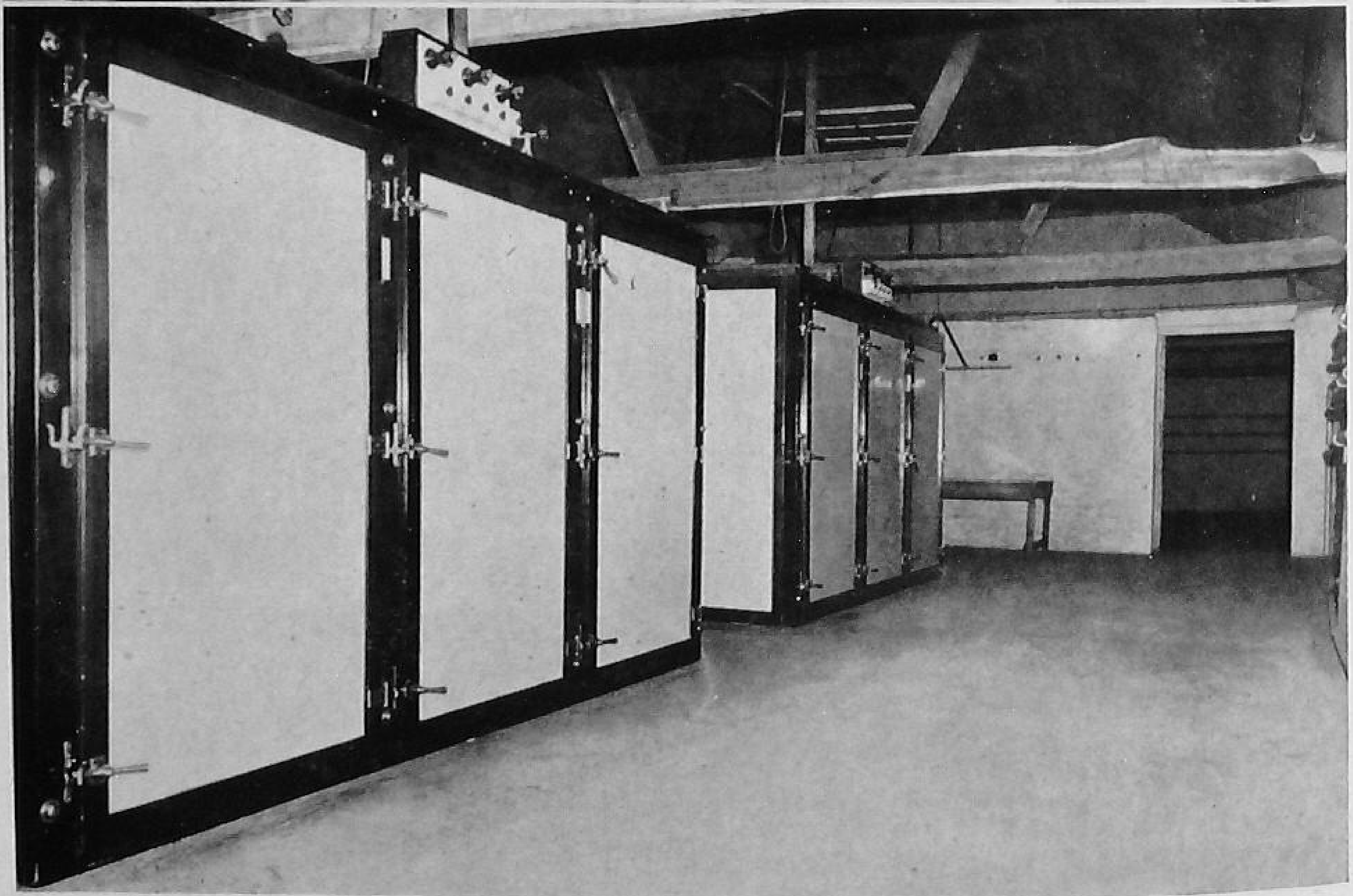


BRITISH BREEDS OF PIGS

Above : WESSEX SADDLEBACK

Below : LARGE WHITE

Farmer & Stockbreeder Photographs



MODERN POULTRY FARMING

Above : HEATED AND AIR-CONDITIONED TIER BROODER HOUSE

Courtesy: Nackington Farms

Below : PART OF HATCHERIES, NACKINGTON FARMS. UP-TO-DATE MACHINES WITH SEPARATE HATCHERS AND MODERN METHODS OF HYGIENE ARE USED

Courtesy: Nackington Farms
Farmer & Stockbreeder Photograph

Prolific Strains.

1. *Natural Prolificacy.* Some breeds are naturally more prolific than others, though information on this point is far from complete. Some figures are given in Tables V and VI. Within each breed there are strains which are more prolific or less so. There is no great advantage in producing a large number of piglings at a birth if the sow's capacity for giving milk is low or if she has too few teats to supply each pigling with its own teat. If a sow, for example, produces 12 pigs and has only 10 teats, two of the piglings do not get their share of milk and will be stunted in growth; from such a set-back at the beginning they rarely recover and are uneconomical to rear to pork or bacon weights. It is usually better to kill them so as to release the amount of milk they consume for the benefit of the other piglings. Up to 20 pigs have been reared in a litter by an exceptional sow, with exceptional feeding, but whilst the weight of the litter as a whole at 8 weeks was certainly very large, the weight of the individual pig was undoubtedly very small and it is doubtful if the subsequent progress of most of the pigs was economical. The number of teats is the limiting factor in deciding how many piglings to leave with a sow; she should never be selected unless she has 12 sound teats. If it is so arranged that sows farrow in batches, the surplus pigs from one litter can be put on to another sow. Sows as a rule accept these foster piglings quite readily. The unsucked teats dry up, but of course produce milk again if required by the next litter.

The most complete information on the subject of prolificacy is contained in a paper by A. W. Menzies-Kitchen. From an extensive analysis of records obtained in the Eastern Counties he found that the litter sizes and percentage survival at 6 weeks were as shown in Table V.

TABLE V.

Breeds	Number of Litters	Number of pigs per litter born alive	Number of pigs per litter alive at 6 weeks	Percentage survival at 6 weeks
Large White	530	10·2	7·8	76·2
Large White × Large Black	628	9·3	7·7	83·1
Large White × Saddleback	177	9·8	7·7	79·1
Large White × Cross-bred	171	10·1	8·3	82·0
Middle White	171	9·7	8·1	83·5
Middle White × Large Black	82	9·6	8·0	82·9
Large White × Middle White	86	10·4	9·0	86·2
Large Black	132	8·6	7·1	82·4

Other figures are available in the hands of County Pig Recording Societies.

Further information from A. W. Menzies-Kitchen's same excellent paper includes the litter records of the various breeds recorded by the National Pig-Breeders Association.

TABLE VI.

Breed	Number of litters recorded 1935	Number born	Number weaned	Percentage survival at weaning
Large White	13,071	1·041	8·10	77·8
Middle White	1,150	9·60	7·58	79·0
Berkshire	210	8·77	6·95	79·3
Tamworth	68	7·74	65·3	84·4
Wessex Saddleback	1,094	10·11	8·32	82·3

The number of pigs weaned depends partly upon the weather conditions and, therefore, to a certain extent on the month of the year in which the litter is born. Menzies-Kitchen found that litters during the 6 months April-September contained three-quarters of a pig more than those farrowed during the remaining 6 months of the year. Litter size increases up to the 8th litter born to a sow and only falls seriously again after the 10th litter.

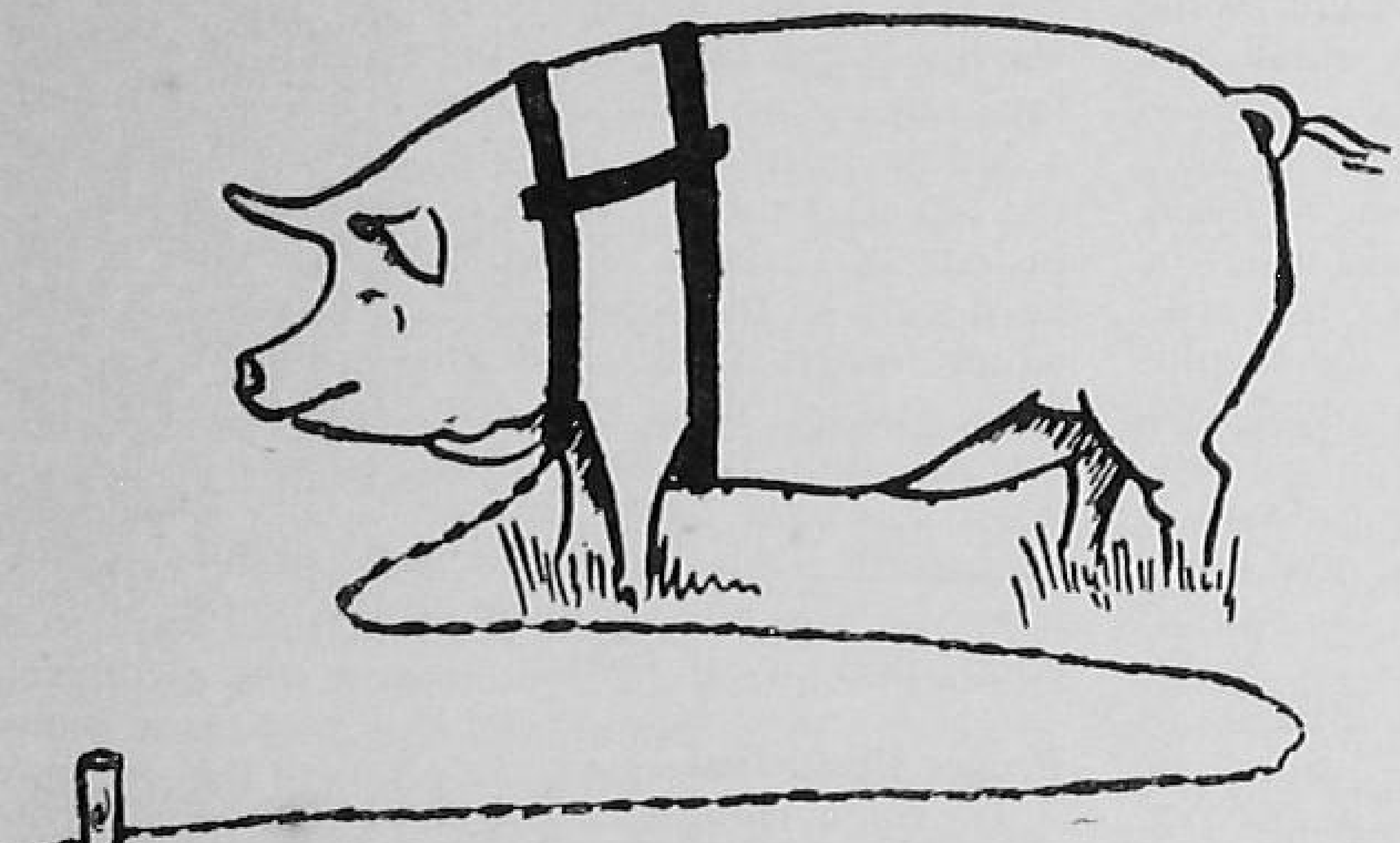
2. *Proportion of Gilts to Sows.* It is common practice when buying a herd of pigs prior to starting a pig farm, or a pig section of a mixed farm, to obtain a certain proportion of gilts and a certain proportion of sows. This ensures that the replacements for the herd are made gradually instead of in bulk as would be necessary if the herd were all of the same age. Moreover, a herd which consisted entirely of gilts would have a low litter average since gilts rear from 1–2 piglings less per litter than sows.

3. *Freedom from Disease.* This subject is adequately dealt with in the pages about diseases (pp. 675–677) and on those on the rearing of the young pigs (*see* p. 664).

Proper Protection.

4. *Good Housing.* This subject is dealt with fully in pp. 649–657, but it is relevant to discuss here the merits of the commonest systems of housing sows from the point of view of the owner and of the sow. Whatever system is adopted, it is essential that the sow should have a dry, warm sleeping place with plenty of ventilation, but free from draughts and with a corner that is out of the direct rays of the sun. This can easily be provided in a range of farrowing sties facing south and equipped with an open-air compartment. The sow and litter can be admitted to this or excluded by means of a door on the indoor compartment. Buildings of this type have the advantage that they can be used equally well for any kind of fattening stock. Satisfactory houses can also be made from baled-straw, the bales being protected by wire-netting to prevent the pigs from pulling the bales to pieces. Corrugated iron buildings of a similar type tend to be cold in winter and hot in summer. Baled-straw houses and corrugated iron houses are not mobile and if a house is required for moving round a grass field, fold houses or huts with the sows tethered may be employed. Each fold unit has a house with a small run attached and it can be moved daily on to fresh ground.

This prevents the churning up of grassland that occurs in fixed open-air runs and also makes certain that any worm infestation is left behind as the huts are moved along. Such a system naturally involves a good deal of work in moving the houses, but avoids the labour and cost of erecting and moving fences. The grassland should, of course, be dry if the system is to be used during the winter: grassland is considerably improved by this system and the manure is applied direct to the land. It may be desirable to allow the sow to farrow in permanent indoor buildings, so that the pigman can more easily be in attendance. In such a case the sow and litter should subsequently be moved into a fold unit. The same remark applies to tethered sows, which are fastened by a stake and chain so that they have a radius of movement of some 30′. The length of their chain enables them to reach the inside corners of their house, but is not long enough for them to get round the back of



METHOD OF TETHERING A SOW
FIG. 16

their house on the outside. The litter, of course, is free to go where it wishes.

The advantages of exercise and grazing cannot be too strongly emphasized and any system of management should, if possible, incorporate a grass run.

5. *Good Feeding*. Young pigs and pregnant or suckling sows require a higher proportion of protein than empty sows or pigs towards the end of their fattening period. This proportion of protein is known as the nutritive ratio and is explained in the pages on feeding stuffs (*see* page 645). In-pig sows are commonly run out on pasture or may have wired runs in suitable woods if these are available. In summer they will obtain part of their keep on grass and the ration, early in the gestation period, may well be reduced to 2 lb. of meal per day. In winter, when the sows are probably wholly indoors and particularly later in the gestation period, the meal ration will be about 6 lb. per day. The safest way of expressing the ration is to say it is 2–6 lb according to the condition of the sow and it nutritive ratio should be 1 : 5.

Suckling sows may also be run outdoors, bu their ration should only be cut very slightly below the usual 2 lb. of meal for the sow plus 1 lb. fo each pig in the litter (*i.e.* a sow with 8 pig received 2 plus 8 lb. meal = 10 lb. per day). Thi ration suffices for the sow and litter for severa weeks until the young pigs start to eat mea themselves in addition to getting benefit from th 10 lb. per day which is fed to the sow. Th nutritive ratio should again be 1 : 5.

It is quite possible to use only one ration for th breeding stock. This will vary from time to tim as changes in the price of feeding stuffs an variations in the supply of home-grown meal occur. A number of different standard ration recommended for in-pig and suckling sows ar set out in the following table. (Table VII.)

When grass is not available a regular allowanc of other green food should b given and attention should b paid to the mineral ration if th sow is kept indoors; this is par ticularly important where protein rich vegetable foods are used in stead of protein-rich animal foods

Lime is an essential require ment for a pregnant or milkin animal and a deficiency will resul in pigs being born dead or dying during the first few days of thei life. There were many cases o this reported during the war years.

6. *Mating*. Females should be mated on the second day of thei heat period. The heat period, which is usually characterized by the excitable behaviour of the sow and a reddening of the external reproductive organs, may not always be very noticeable and the herdsman should try to keep a record of the expected day for each sow. If the empty sows and

TABLE VII.

	1 or	2 or	3 or	4 or	5 or	6 or	7 or	8 or	9
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Barley Meal .				37½	37½	15	15	15	25
Weatings .	40		25	45	40	45	45	35	
Maize Meal .	50	35	30						50
Fish Meal .	10				10	10	10	10	10
Bran .		15					10	10	
Wheat Meal .		40						15	
Rice Meal .									15
Meat and Bone Meal .	10								
Crushed Oats .			30						
Whalemeat Meal .			5						
Ext. Soya Bean Meal .			7	2½	2½				
Spray Dried Sep. Milk .				10					
Flaked Maize .					10	20	20	15	
Minerals .			3						
Palm Kernel Cake Meal .						5			
Lucerne Meal .						5			

gilts are running together out of doors the boar can be taken down to their pen when one of them is on heat, or he may be run out with them or the female concerned may be taken up to the boar. The disadvantage of running the boar with the females is that the actual date on which a particular sow is served is often unknown. In addition to this, if two gilts are on heat at the same time the boar may serve both on the same day. The heat period lasts three days, so if he is not running with them service can be arranged on consecutive days. This is better for the boar and more likely to result in conception.

After mating, the sow should preferably be run on pasture where it obtains green food with a consequent saving of some meal; moreover, the animal thus obtains healthy exercise.

7. *Farrowing*. The sow should be put in her farrowing quarters at least a week before the date on which she is due to farrow. This is most important and many unsatisfactory results may be attributed to changing a sow's quarters just before farrowing. She need not be confined to the sty during the day, in fact it is better to let her out on to grassland for her customary exercise. Any signs of constipation can be dealt with by replacing half her normal meal ration by bran mash as it is most important at this time that constipation be avoided.

The approach of parturition is indicated by enlargement of the vulva and slackening of the muscles on either side of the tail. About 12 hours before farrowing, milk will form in the sow's teats and the udder will become distended. By this time a quantity of clean short straw should have been provided; this may be chopped wheat straw or oat chaff, but long wheat straw must be avoided as it hinders the movement of the young pigs when they try to reach the sow's teats. From this short straw the sow will usually make a bed.

The sow almost invariably lies down whilst her young are born and although parturition may take an hour or two, she will rarely need any help. A quiet and efficient pigman, known to the sow, should however be in attendance. The young pigs weigh about 2½ lb. and are thus very small in proportion to the sow. This probably accounts for the usual lack of trouble at birth. The pigman should see whether any of the little pigs have overgrown, sharp teeth, since these are painful to the sow during suckling. In such cases the tops should be nipped off these teeth with a pair of pincers, the piglings being taken out of earshot of the sow whilst this is done. The pigman should also make certain that the young pigs do not get chilled, that they quickly get dry and get round to the sow's teats. If the weather is very cold it may be a good plan to put the young pigs into a basketful of wheat chaff or hay until they are dry and warm.

If the pigman considers that the sow needs any help he must make certain that his hands are perfectly clean before he carries out his examination and should smear his hand with carbolized vaseline before it is inserted into the passage.

The afterbirth (placental membranes), or cleansing as it is often called, should come away quickly after the last pig has been born. It should be removed from the sow, who will try to eat it if it is left within reach.

The first meal given to the sow should if possible be warmed to blood heat, and this is, of course, particularly important in cold weather. The ration should be kept low for the first two days after farrowing.

Much has been written on the subject of farrowing, and Morrison and Sanders Spencer devote considerable space to this subject in their books mentioned in the list of literature at the end of this book (page 685).

Steady Progress.

Rearing the Litter. It is absolutely essential that a litter of pigs should make steady progress from the time of birth to the date of killing in the case of fattening pigs and from birth until mating in the case of breeding pigs. There must be no store period such as there is in cattle where fattening is undertaken on grass at a more mature age. There is no period in its life when the maintenance of this steady growth is so important as it is during the first 12 weeks of the pig's life and malnutrition during this period is likely to create weaknesses which may cause trouble in after life. For example, meal mixtures too low in mineral content may result in a sow producing pigs with weak bones, and this may cause lameness later in life. Too low feeding of the sow may cause her milk to be short and all the many other points of good management must be borne in mind. The consideration of some of these points of management is the purpose of this section.

It may be assumed that a healthy litter of pigs is about to be born, that the sow is adequately housed and bedded and that if the weather is abnormally cold a hurricane lamp or other form of heating has been installed in the sty. If the sty is draughty thatched hurdles should have been erected or some other form of protection devised. The pigman will be in attendance to assist should it be necessary.

Some pigman place each pig as it is born in a boxful of wheat chaff, where it is kept until warm and dry, but this should only be necessary in very cold weather. The pigmen should make certain that the pigling's mouth is clear of membranes and that it is breathing properly. Under normal circumstances the young pig gets to its feet within a few minutes of birth and makes its way round to the sow's teats. The warm sow's milk has an almost instantaneously beneficial effect and if the young pig does not quickly avail itself of this, the attendant should place it beside the sow's udder and if necessary help it to start sucking by

placing a teat in its mouth and squirting a little milk into its mouth.

The birth may last an hour or two, at the end of which the placental membranes should come away.

For the first few days the pigling will suck from any teat, but eventually will select one teat and will seldom suck from any other. Usually the strongest piglings use the teats nearest to the forelegs and these teats usually produce the most milk. If there are more piglings than there are teats it is usually advisable to kill the smallest pigs, leaving only the same number of pigs as teats. This should not be done for a day or two, as there is nothing more annoying than killing 2 or 3 pigs to reduce numbers and then losing one or two of the remainder, and so leaving the litter below strength.

The sow's milk alone is sufficient for a young pig for the first fortnight at least. At the age of 2–3 weeks it will usually drink a small quantity of liquid in addition to its mother's milk. At 3 weeks old it will eat a few mouthfuls of dry food from a trough placed out of the sow's reach and at 4 weeks old this quantity will have risen to an ounce a day. At 6 weeks old it will eat a measurable quantity of food per day and this can now be fed wet instead of dry. The increase in the young pig's appetite is well shown by the following records of 4 litters at Wye:—

TABLE VIII.

Litter	Lb. Meal per head during first 6 weeks	Lb. Meal per head *per day* at 6 weeks	Lb. Meal per head during 14 days 6–8 weeks	Lb. Meal per head per day at 8 weeks	Weight at 8 weeks
1	1	·8	11	1·2	34·4
2	2	·4	8	1·0	27·6
3	1	·3	6·5	·6	25·0
4	0	0	5	·5	22·0

As would be expected it was the litter which began to eat a fair quantity of food at the earliest age that reached the greatest weight at 8 weeks.

Sleek, Shiny Coats.

Nothing can be done to stimulate the young pig's appetite; it develops or does not develop. A litter of pigs that is doing well will have sleek shiny coats and is easily distinguished from an unthrifty litter which will have harsh, staring coats. Lack of bloom on the coat may be due to shortage of milk, poor quality milk, ill health, bad housing or worms. As a rule the larger pigs in a litter will start to eat food first and will take a greater quantity than the smaller pigs in the same litter. Frequently in a litter there are one or two very small pigs; in different parts of the country these have different names—runts, wrecklings and ' the parson's pig ' amongst them. The runts in a litter will not as a rule be economical to rear, especially if they are without a teat of their own to suck. If they have no teat they will only be able to obtain a little milk from another pig's teat and they will be even worse off than a runt which has at least got a teat of its own.

The smallest economic litter is 6 pigs, whilst 8 or 9 is the ideal litter. Some sows will rear 10 or 12 pigs; this will undoubtedly produce a heavier total weight per litter but the individual weights will be smaller.

At 4–5 weeks the boar pigs not required for breeding are castrated. This is a simple operation carried out by the owner or pigman without anæsthetic. An assistant is required to hold the pigs; this he does by gripping the pig's hind legs with his hands and holding the hind legs apart. The body of the little pig is gripped between the knees, so that the tail end of the pig is exposed to the operator. The skin where the cuts are to be made should be painted with iodine or strong disinfectant and the operator's hands must be clean and rinsed in disinfectant. An extremely sharp knife which should have been left standing in disinfectant for some time must be used. The bag should be gripped so that one testicle at a time is squeezed tight against the skin and gripped between the finger and thumb of the left hand. With the knife in the right hand a bold incision about an inch long is made. This should be one clean cut. It must cut through the skin and through several layers of membrane, which surround the testicle. These membranes are parts of the abdominal wall, which are carried into the bag when the testicles descend from the region of the kidneys where they lie until just before birth. As the incision is made the pressure of the finger and thumb squeeze the testicle through the wound. The testicle is then gripped between the left finger and thumb and drawn out until the cords attached to it are exposed. One of these cords is hard and carries the sperm; it should be cut off several inches away from the testicle. The other cord consists of blood vessels and nerves and it is usually cut off closer to the testicle. The other testicle is now dealt with in the same way, the two cuts being neat and close together. Disinfectant should be immediately applied to the wound and the pigs should be returned to a bed of clean straw. The operation is usually carried out without risk and has surprisingly little ill-effect upon the little pigs.

It is not usual nowadays to spay the female pigs; this consists of the removal of the ovaries by an operation carried out in the flank of the pig. The incision in this case is sewn up, whereas the incisions in castration are not. No anæsthetic is used.

Marking Piglings.

It is usual to tattoo the ears of pedigree pigs at the same time as the operation of castration or spaying (if any) is being carried out. Black pigs, of course, cannot be tattooed, as the tattooing ink will not show up, so that they are marked by cutting notches out of the ear. This is unsightly

from the point of view of show pigs, but has the advantage that the numbers can be read without the pig being caught. On account of this advantage notching of the ears is frequently used in commercial herds—a convenient system of notching is shown in Fig. 17. The notches in the ear may possibly be destroyed if fighting takes place amongst the pigs. With practice, the notches can be cut very quickly and whilst a little bleeding usually takes place, little inconvenience is caused to the young pigs.

At this stage also it is usual to note for discard any female pigs having less than twelve teats.

It is necessary at this time to have made adequate provision for the young pigs to eat their food away from their mother; this can be done by dividing off a corner of the sty by means of wood battens and placing the trough behind the barrier; the young pigs can get underneath the battens, the sow cannot. The food provided in this creep, as it is called, from the age of say 4 weeks will consist of one of the many suitable mixtures for sucking pigs. Some of these are shown in Table IX, and at the age of 6 weeks it may be assumed that the young pig will consume about ½ lb. per day.

TABLE IX.

The Composition of Three Different Suitable Mixtures for Sucking Pigs.

	per cent	per cent	per cent
Barley Meal . .	25	30	20
Flaked Maize . .	15	15	10
Weatings . . .	45	45	50
Fish Meal . .	5	10	10
Dried Separated Milk .	10	—	—
Bran . . .	—	—	10

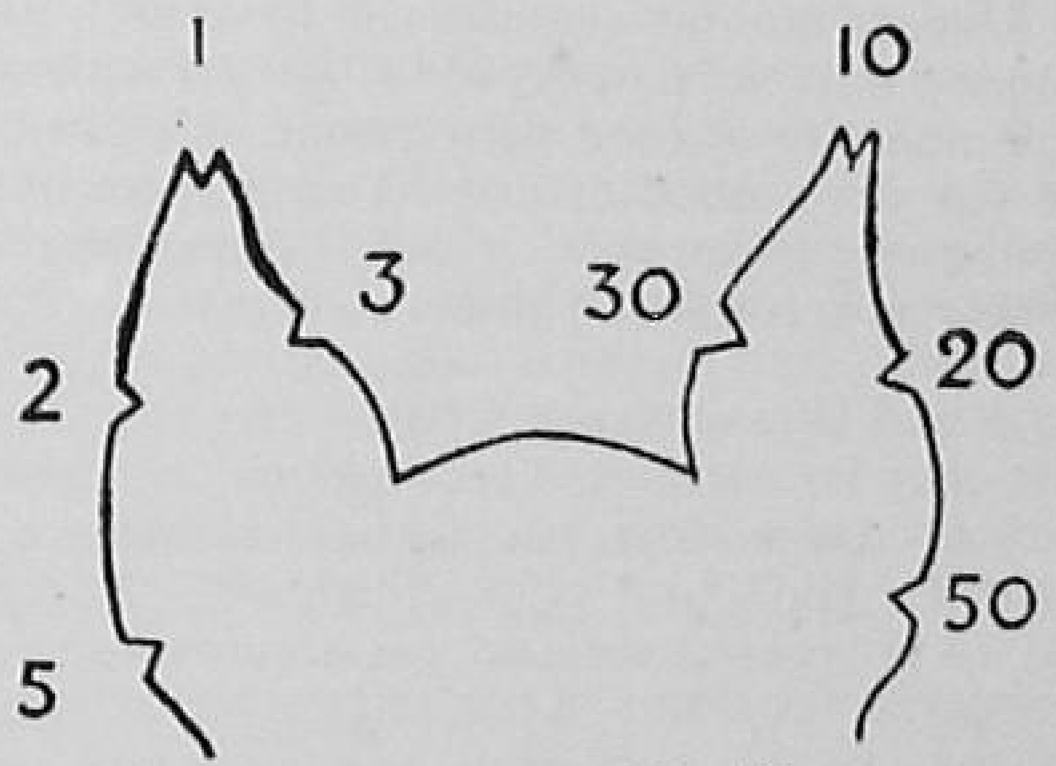
Good litters at Wye on war-time rations reached the following total weights at 8 weeks.

No. of Piglings	Total weight in lb.	
6	210	
8	210	First litters
10	285	10–20 per cent
12	320	less
14	350	

The young pigs will start to drink cows' milk at 3 weeks, but it is very unlikely that such a commodity will be available. Separated milk if it is available is invaluable at this age.

The sow's milking capacity should be such that she can rear her litter to the age of 8 weeks; this is more satisfactory than weaning it at 6 weeks and more economical in time than leaving them with her until 10 or 12 weeks.

Between the ages of 3–6 weeks young pigs, particularly if they have any sort of check, tend to suffer from anæmia. This need not affect the whole litter and sometimes only one or two pigs will suffer. The symptoms are a lack of bloom in the coat, a pallid colour and lack of appetite. It is cured by iron preparations, the simplest to use being Parrish's food, which at Wye is put on the tongue with a paint brush at the rate of one dram per pig per day. If most of the litter are anæmic they may be given their Parrish's food in water away from the sow at the rate of 1 oz. to 1 pint to 8 pigs; they will usually drink this without trouble. This should always be given to litters as a precautionary measure, except for litters on grass during the summer. Between the months of March and October piglings reared with an outdoor run progress more rapidly than indoor pigs and are less likely to suffer from anæmia and digestive disorders. In winter on dry land sows and litters may be run out, but not on land where the soil quickly gets turned into a sea of mud. Good conditions can be achieved by having grass runs in front of the farrowing range or by means of fold units or tethering.



METHOD OF NOTCHING PIGS EARS
FRONT VIEW
FIG. 17

Weaning.

Weaning takes place at 8 weeks, so that the sow has had 16 weeks in pig, 8 weeks suckling and has thus 2 weeks to spare if she is going to do this sequence twice in the year. A few selected pigs for breeding or show may be left on the sow for another 2–4 weeks and this is very sound practice where circumstances demand it. The sow and the pigs to remain with her are removed from the remainder of the litter. When the ordinary litter is weaned the daily ration must be carefully adjusted so that the trough is clean in half an hour; feeding should take place three times daily. The ration should be increased as quickly as possible otherwise a post weaning check may occur, which is a serious thing and one that will be difficult to overcome.

This check may be minimized by adding dried separated milk to the ration and giving 1 oz. of codliver oil per head per day to backward pigs.

Diarrhœa or scour, which occurs frequently in

piglings as a result of digestive disturbances, is cured by lime water or chalk in the ration. The trouble may be caused by an alteration in the sow's milk due either to a change in the ration or a flush of grass. If the scour is persistent one tablespoonful of castor oil should be given to each pigling.

The process of weaning should not cause undue trouble provided that the litter is healthy and has been brought up to eat food independently of the sow. The sow should be taken away from the litter and not the other way round; in this way the litter does not have the double shock of losing the sow's milk and having to adjust itself to a new house at the same time. The sow's milk will normally dry up in a few days without any trouble and weaning is sudden and complete; it is not wise to adopt a gradual process where the litter is allowed to suckle the sow in gradually reducing amounts.

The litter should be treated for worms at this stage.

A Good Boar.

Management and Selection of the Boar. There can be no more futile economy than trying to save a few pounds on the herd boar. In an average herd a boar will serve 20–30 sows twice during the course of a year, which means that he is responsible for 40–60 litters. If 8 pigs are reared per litter, then the boar influences the conformation and characters of 320–480 pigs per annum. He may be used for 4 years which increases his influence to 1,280–1,920 piglings. It is easy to see that if a good boar can increase the selling price of his progeny by even 6d. per head over that of a moderate boar, he will put into the owner's pocket a considerable sum of money in the course of his life.

A pure-bred boar of the required breed should be purchased and he should not only be a good specimen of his breed, but should be particularly strong in any points in which the sows are known to be weak. If possible the purchaser should see the parents of his boar and should select him from a large litter; this means that he is from a prolific strain. The boar will not influence the number of piglings in the the litters he sires, since he produces enough spermatoza at one service to fertilize millions of eggs; the number of piglings in litter depends on the number of ova or eggs released by the sow.

The boar, if he is from a prolific strain, will, however, be more likely to produce prolific daughters than a boar from an unprolific strain. The various pig recording societies are the greatest help in enabling such records of prolificacy to be obtained. The boar, if it is possible to obtain the necessary information, should be selected from docile parents, so that he himself is more likely to be docile. A bad tempered boar is an extremely unpleasant animal to deal with, and what is more, he may produce restless progeny, which will not fatten so well as more docile pigs. The very large sums of money paid for pedigree boars are only justified where the owner's object is the production of pedigree pigs for sale as such. The boar may be bought privately from a breeder or by auction at one of the breeders' annual sales of surplus stock or at a breeders' dispersal sale.

The boar may be used first when 7–8 months old and will probably have been purchased 2 or 3 months previously. It is not advisable to buy the boar as a weaner of 8 or 10 weeks old since at that time he is not developed and his good and bad points may not be very obvious. The energies of the boar are wasted if he is run out with the sows and he will frequently serve the same sow several times during the 3 days she is on heat. It is better for him to have the sows brought to his sty or pen and to serve them only once. The number of sows which a boar will serve in a year, as mentioned earlier in this section is 20–30 but this will depend on the vigour of the boar and the standard of feeding given to him.

Feeding.

The boar should be fed on the breeding sow ration and should receive 3–6 lb. per day according to the number of services he is having, the weather, the supply of grass or other green food. When purchased he should not be too fat; yet frequently fat boars are seen at pedigree sales. Throughout his breeding life the boar should be kept in healthy condition and not allowed to put on surplus flesh. Finally when he is disposed of at the end of his useful life it is not worth trying to fatten him up, since the price realized for him is bound to be low in any case.

During his breeding life he should be housed away from the breeding sows and gilts, otherwise he will be restless and difficult to deal with when one of them is on heat. He may also break down fences and generally make a nuisance of himself unless adequate housed. By the Improvement of Livestock (Licensing of Boars Regulations, 1945), it is illegal without a licence or permit, to keep a boar after 30th September, 1945, once it has reached the age of six months. Only pure bred boars are eligible and forms of application for a licence should be obtained from the Secretary, Ministry of Agriculture and Fisheries, 4, Bickenhall Mansions, Bickenhall St., London, W.1.

Policy.

The Rearing of Breeding Stock and its Selection. It pays to breed fattening pigs on the farm wherever practicable, because each time pigs are brought on to the farm the risk of disease is incurred and the young pigs may be bred from parents having a tendency to be excessively fat or excessively lean. In this way also you retain the profits of both breeder and fattener. If such a policy is adopted the selection and rearing of the breeding stock is a most important part of the pig-keeper's skill. However, should it be

necessary to buy young pigs for fattening, they should, of course, be bought from a breeder whose stock is known to give satisfactory results.

It is the purpose of this section of my book to outline the points to be observed in selecting and rearing breeding stock on the farm.

The boar, which influences all the pigs born on the farm must have been wisely selected. The sows likely to produce good breeding stock should be chosen for the excellence of the records of their earlier performance, while the home breeding stock must be selected from suitable litters. The sows from which the breeding pigs are selected must have good conformation, be prolific, quiet and should be capable of rearing 9 or 10 pigs per litter. The sows should be long, light in the shoulder, have at least 12 teats and be constitutionally sound.

It is from such selected sows as these that the litter will have been born; and it is assumed that they will have been reared as previously described to the age of 8 weeks, having the same treatment as pigs which are being reared for bacon or pork production. Their weight at the age of 8 weeks will be about 30 lb. and the boar pigs not required for breeding purposes will have been castrated at the age of 4–5 weeks. At the time of castration the pigs will all have been ear-marked (Fig. 17). Those pigs intended for breeding may be left with the sow for 2–4 weeks longer if necessary to ensure a really well grown weaner boar or gilt.

At 8 weeks old the gilts in the litter should be critically examined. Those intended for breeding must be true to the type required as regards breed, length and lightness of shoulder. They must have at least twelve sound teats. Inevitably there will be wastage as the gilts develop. Some of them may develop faults not at first apparent, some may not develop as well as anticipated and some may be lost through illness or accident, so it is necessary to select at 8 weeks more gilts than are actually required and if possible twice as many gilts should be included amongst the young breeding gilts as are finally required. This enables the owner to have a further critical examination and to discard those which do not come up to his expectations. This second examination should be made when the animals are about 6 months old and any surplus gilts can then be disposed of either as breeding gilts or as fattening pigs.

After weaning, the selected gilts should be run out of doors if possible, particularly in the spring and summer months. Woodlands or grass runs on dry land are ideal for this purpose, the fresh air and exercise being very beneficial to healthy development. There is nothing to be gained in the winter by running the gilts on wet grassland which quickly becomes a quagmire and there is certainly no economy in food consumption since the gilts require a great deal of food to maintain their body temperature and to replace the energy expended by the exercise they are taking. Exercise, whatever rearing system is adopted, is most important and it should be provided for the gilts even if it is only for a short time each day.

Houses on grass may consist of huts made of straw bales, thatched hurdles or wood. Fold units, owing to the labour involved in moving them, are not practicable and tethering is, of course, impossible owing to the number of tethers required, since only one pig can be tethered near each hut. They can be satisfactorily reared indoors where some form of exercise is impossible.

The feeding of growing breeding stock is important and the idea that they require indifferent feeding as compared with fattening stock should be forgotten. The ration recommended for sucking pigs should be continued for two or three weeks after weaning. For some weeks they should be fed three times daily and under no circumstances should they be kept short of food, but on the other hand they should not be allowed to become too fat. The consumption of meal per day is shown in Table X.

When the sucking pig ration is discarded at, say, twelve weeks, one of the following may be used.

TABLE X.

Percentage Composition of Three Approved Rations for Young Breeding Stock

	1	or	2	or	3
Weatings	40				25
Maize Meal	50		35		30
Bran			15		
Wheat meal			40		
Crushed Oats					30
Fish Meal	10				
Meat and Bone Meal			10		
Whalemeat Meal					5
Extract Soya Bean Meal					7
Minerals					3

PORK AND BACON

Here our author reviews the production of pork and bacon pigs from weaning to marketing. Feeding, housing, grading and the selection of breeds are discussed. The factory and farm processes of killing and curing bacon pigs are considered. An account is given of the uses of the parts of the bacon pig.

Production of Pork Pigs.

Modifications.

In the case of pork the demands of the consumer have changed as much as they have with beef and bacon; a comparatively lean joint of pork is now required and one of much lighter weight than was the case years ago. Consequently, breeds which have a tendency to be short and fat are now being modified by breeding and selection into something longer and leaner. In every breed there is considerable variation and it is up to the breeder to select the right type for his particular requirements. The long, lean type of porker is most likely to be produced from such long breeds as the Large White, Wessex, Essex or other long breed, or from crosses between two of these breeds. The compact type is more likely to be produced from Middle Whites, Berkshires or their crosses; owing to the fact that they put on flesh at an early age, these last two breeds provide a lot of pork for the London market where the demand is for smaller pigs.

It must be borne in mind that the pork trade suffers from a serious disadvantage as compared with the bacon trade. The demand for pork in hot weather naturally falls off, so that during May, June, July, August and possibly part of September, the market is very slow. It is necessary so to organize herd production that the majority of the pigs are marketed during the cool weather and that a satisfactory alternative market in the months of May to September is arranged for litters born in the spring, so that they can be sold as baconers or weaners.

The dead weight classification for pork pigs as recommended in the Report on the Marketing of Pigs (Ministry of Agriculture: Economic Series No. 12) is as follows:—

Dressed Weight.

Porkers ..	60–80 lb. ..	(3–4 Score)
Porkets ..	80–100 lb. ..	(4–5 Score)
Cutters ..	100–140 lb. ..	(5–7 Score)

For two or three weeks after weaning, the young pigs will be run on grass or in the sty in which they were reared, being fed on the same ration as they received as suckling pigs. Their house, whether it be a permanent sty or a temporary shelter must be warm and draught proof and supplied with plenty of litter. It is useless to expect satisfactory progress from any pig under cold or damp conditions. The feeding of the pigs from the age of twelve weeks until they are marketed will depend upon the local availability of feeding stuffs and also upon the intended age of marketing. Any of the following rations are recommended for use.

Table XI.

Rations all suitable for small porkers (Killed 60–100 lb. L.W.).

	lb.	lb.	lb.
Barley Meal . .	30	30	27
Flaked Maize . .	15	20	20
Superfine Weatings .	15		
Weatings . .	25	40	35
Bran . . .	5		
Bean Meal . .			10
Fish Meal . .	10	10	
Meat and Bone Meal.			5
Minerals . . .			3

Table XII.

Rations all suitable for pork pigs (Killed between 100–120 lb. L.W.).

	12 weeks to 80 lb. L.W.	12 weeks to 80 lb. L.W.	12 weeks to 80 lb. L.W.	80 lb. L.W. to Killing	80 lb. L.W.to Killing	80 lb. L.W. to Killing
	lb.	lb.	lb.	lb.	lb.	lb.
Barley Meal .	30	30	15	40	40	15
Flaked Maize	15	15	15	20	15	15
Weatings .	45	40	30	30	35	25
Bran . .		5	5			
Wheat Meal.			25			35
Fish Meal .	7½	5	5			
Ext. Soya Bean Meal	2½	5	5	10	5	5
Meat and Bone Meal					5	5
Minerals .				3		

Pigs which are to be killed between 120 lb. and 180 lb. in weight should receive any of the rations in the first three columns of the above table between the age of 12 weeks and the age when they reach a live weight of 100 lb. After reaching the weight of 100 lb. they receive any of the rations in the last three columns until they are marketed. These finishing rations, as they are called, contain a smaller proportion of weatings and a higher proportion of the starchy foods such as barley meal or wheatmeal; in addition, the fish meal is usually omitted and soya bean meal or meat meal substituted for it, in order to avoid any possibility of fishy flavour in the carcase.

Commercial pork pigs will normally be fed twice daily and only in the case of show pigs is labour made available for a third feed. The quantity to be fed must be gauged by the pigman; it should be so limited that all food is cleared up within 20 minutes of feeding. The quantity consumed by pigs of various ages and weights is shown in Table XXI on p. 686, and is obviously subject to variation in individual requirement.

Where possible, for pigs which are being fed indoors, green food should be provided up to 6–8 lb. daily.

Requirements.

Production of Bacon Pigs. The present day bacon requirements of the housewife are for lean bacon. There must be a fair proportion of lean meat to fat from whatever part of the pig the purchaser chooses to buy her bacon and the quality of the bacon must be consistent. For many years before the 1939–45 war the Danish bacon had fulfilled these requirements, whereas the home produced bacon might be from large or small, from lean or fat or from young or old animals. The Pigs Marketing Board were already overcoming this unsatisfactory state of affairs when the war started, and grading, as we knew it before the war, was abandoned. The object of pig-keeping in war-time was to produce the maximum quantity of food from whatever feeding stuffs were available and the only stipulation made by the factory was that the weight of the pig must be between certain limits. When grading was in operation, the difference between a good grade pig and a bad one made all the difference between profit and loss. This condition will undoubtedly operate again when adequate grading comes into practice as soon as there is a return to more normal conditions. The bacon producer of the post-war years will, therefore, have to concentrate upon producing the required type of pig, from the right breed or cross and the details of production will have to be studied in every particular, beginning with the mating of the parents and only ending with the killing of the bacon pig.

Figures obtained from the records of an Eastern Counties bacon factory suggest that the Large White should be the sire of all bacon pigs. Satisfactory results were obtained at this factory with pigs out of suitable Large White sows and out of sows of Essex-Large White Cross. The report that gives these figures points out that prolificacy of sows and their ability to rear large, regular litters are vitally important and the grades of pig they produce should not be allowed to assume too much importance. The effect of the boar on the grading of his progeny is, however, of great importance; conformation and consequently the grade of his progeny is all the boar can contribute.

The report on a survey of pig production in S.W. England in 1934 and 1935 emphasizes the superiority of the Large White boar for bacon production, but other pure breeds and many cross-breds produce excellent bacon. The really important item is the selection of the right type of sow and the right type of boar, whatever breed or cross is to be used.

It is desirable to breed your own pigs; in this way suitable sows and suitable boars can be used. Records of the grading of the progeny of these sows and boars should be kept. The influence of breeding on subsequent grading is much greater than is generally realized and records kept at Wye of sows and boars give illuminating information; some of these particulars are shown in Table XIII, which requires some explanation. The grades shown opposite each sow's number in the table are for 4 pigs from each litter, selected at random when 8 or 10 weeks old. These pigs were considered to be representative of each litter.

TABLE XIII.

	Grading by Boar 1			Grading by Boar 2		
Sow	A	B	C	A	B	C
73 .	4			4		
17 .	3	1		4		
1 .	1	2	1	3	1	
5 .	4			4		
2 .	1	2	1	4		
23 .	4			4		
50 .	4			4		
11 .	1	2	1	3	1	
22 .		3	1	3	1	
3 .	3	1		2	2	

This table ample demonstrates the better results from Boar No 2 and consequently gilts by him are preferred to gilts from Boar No. 1. As far as the sows are concerned most of them did well, but good gilts for breeding are expected from sows 73, 17, 5, 23 or 50. We have here an example which shows that intelligent breeding and selecting are fundamental parts of bacon production. It may be added that while faulty conformation cannot be overcome by good feeding, good conformation can be spoilt by bad feeding.

Cross-Breds.

The first cross between two pure breeds is quite satisfactory for bacon production, in fact, Show records reveal that championships have often been won by cross-breds against pure-bred stock. Cross-bred gilts may be used for breeding but their progeny will be much more varied in type than the progeny of two suitable pure breeds. They will produce some pigs which put on excessive fat and some which do not put on enough by the time the pigs reach bacon weight, and so on.

If pure bred baconers are produced all the young breeding stock may be obtained from litters of good bacon pigs. Everything will go smoothly on this system until a new boar has to be introduced. More will be said on this topic in the section on Selection and Management of the Boar.

The values per lb. of the various parts of a bacon pig differ considerably, and consequently, a pig with well developed valuable parts is graded higher than one deficient in this respect. Details of the carcase are hard to assess when the pig is alive, so that grading is done when the

carcase is dressed. The thickness of the back fat is measured at the point where the shoulder fat shows the greatest depth and consequently a light, fine shoulder with the blades not too far apart is a feature of a high grade bacon pig. The points of the shoulder blade should be close together at the withers; this does not have any effect on constitution because those vital organs the lungs and the heart are lower down, and it is a large girth that gives them ample room. The length of the pig is not taken into account in the grading, but as a rule a pig which has great length will have a lean back (anyway at bacon weight) whereas a short stocky pig is liable to have a fat back. Thus, in breeding and selecting for length the breeder is automatically improving the back fat. With regard to thickness of the belly fat, the safest things to look for in the live pig are straightness of underline and depth of sides, and the bad things to note are pot-bellies and shallow sides. A bad belly produces a thin streaky cut, which cooks away almost to nothing.

It seems likely that, when bacon production returns to normal, some form of grading similar to the one employed up to 1939 will be started again. The author, therefore, considers it wise to describe in full the grading system employed before the war.

Grading System (1939).

The pigs are entered in classes according to their weight: Class 1 being between 140–167 lb. dressed weight; Class 2 between 167–180 lb. dressed weight; Class 3 between 181–210 lb. dressed weight and Class 4 over 210 lb. dressed weight.

They are placed in their Grades according to their fat measurements as given in the table below:—

Grade			Class 1	Class 2	Class 3
A	Middle Back	Max.	1,3/16″	1,5/16″	
		Min.	12/16″	14/16″	
	Shoulder	Max.	2/0	2,2/16″	2,4/16″
	Loin	Max.	1,3/16″	1,5/16″	
	Belly	Min.	1,4/16″	1,6/16″	2″
B.	Middle Back	Max.	1,6/16″	1,8/16″	
		Min.	12/16″	14/16″	
	Shoulder	Max.	2,5/32″	2,9/32″	2,12/16
	Loin	Max.	1,6/16″	1,8/16″	
	Belly	Min.	1,4/16″	1,6/16″	1,10/16
C	Middle Back	Max.	1,8/16″	1,10/16″	
		Min.	12/16″	14/16″	
	Shoulder	Max.	2,5/16″	2,7/16″	
	Loin	Max.	1,8/16″	1,10/16″	
	Belly	Min.	1,4/16″	1,6/16″	

The animals must be marketed to conform with the weights of the class of pig for which the contract is made and for any pigs outside these weights payment will be at a lower price per score (20 lb. dressed weight) than if they were in their proper class. Regular weighing of the growing pig is therefore essential, because it is almost impossible for the ordinary pig-keeper to judge weights sufficiently accurately without weighing.

A point of some difficulty is the necessity of estimating the probable live weight of a dead pig, *e.g.* if a Class 1 pig of the smallest possible dead weight loses 30 per cent on killing it will need to be 200 lb. live weight. As 140 lb. dead weight is the minimum for Class 1, it would be safer to select pigs at 210–230 lb., which would probably kill out at 147–160 lb. Pigs which have a tendency to become over-fat should be selected and marketed at the lower weights, whereas pigs having a tendency to become long and lean should be allowed to reach almost maximum weight in their class. It should be remembered that the contents of the stomach and intestines make a considerable difference and that the pigs should always be weighed at the same time of day.

The grade into which a pig will fall, apart from breeding which has been discussed already, may be affected by the management and feeding of the litter almost from birth. The management must be conducted so that the weaner, which is the basic charge in bacon production, is produced as cheaply as possible and that the bacon pig is reared as economically as possible throughout its growth.

The feeding of the sow and litter have been discussed in the appropriate section; the rations recommended for suckling pigs may be continued up to the age of twelve weeks and food should be unrestricted up to the weight of about 70 lb. (food restriction is discussed on page 645). If the pigs are allowed to lose their bloom at any stage, they take a long time to recover and the amount of food required per 1 lb. L.W. increase is then unnecessarily large.

During the all important post weaning period, the pigs should be closely watched for worms and if necessary Santonin, or oil of Chenopodium should be given. At this stage skim milk should, if possible, be fed as part of the ration, either dried or wet; it is more beneficial at this stage than later on. One gallon of liquid skim milk can be mixed with 10 lb. meal mixture and the protein-rich food reduced by half.

Between the live weights of 80 and 140 lb. any of the following rations are recommended:—

Table XIV.

Rations suitable for bacon pigs of 80–140 lb. L.W.

	lb.	lb.	lb.	lb.	lb.	lb.
Barley Meal	25	15	25	35	50	40
Weatings	40	30	35		15	30
Flaked Maize	20	15	20			17
Bran	5	5		10		
Ground Wheat		25		30		
Maize Meal				15	18	
Ext. Soya Bean Meal	5	5		7		10
White Fish Meal	5	5			5	
Skim Milk			12 gls.			
Ext. Palm Kernel Meal					10	
Minerals				3	2	3

Food should be weighed separately for each pen.

From the weight of 140 lb. onwards the pigs are in the finishing period and it is during this time that care must be taken to see that the quality and quantity of the fat and flesh put on are correct. Soft or yellow fat will cause carcases to be rejected; this may be caused by using foods which are too oily or alternatively by under-feeding. Adequate protein is necessary in order to limit the rate at which back fat is deposited during the later stages of fattening. It is not advisable, however, to feed fish meal during the last fortnight and this should be replaced by low oil content Meat Meal, Whalemeat Meal or Extracted Soya Bean Meal. Suitable rations for the finishing period are as follows:—

TABLE XV.

Rations suitable for bacon pigs over the weight of 140 lb.

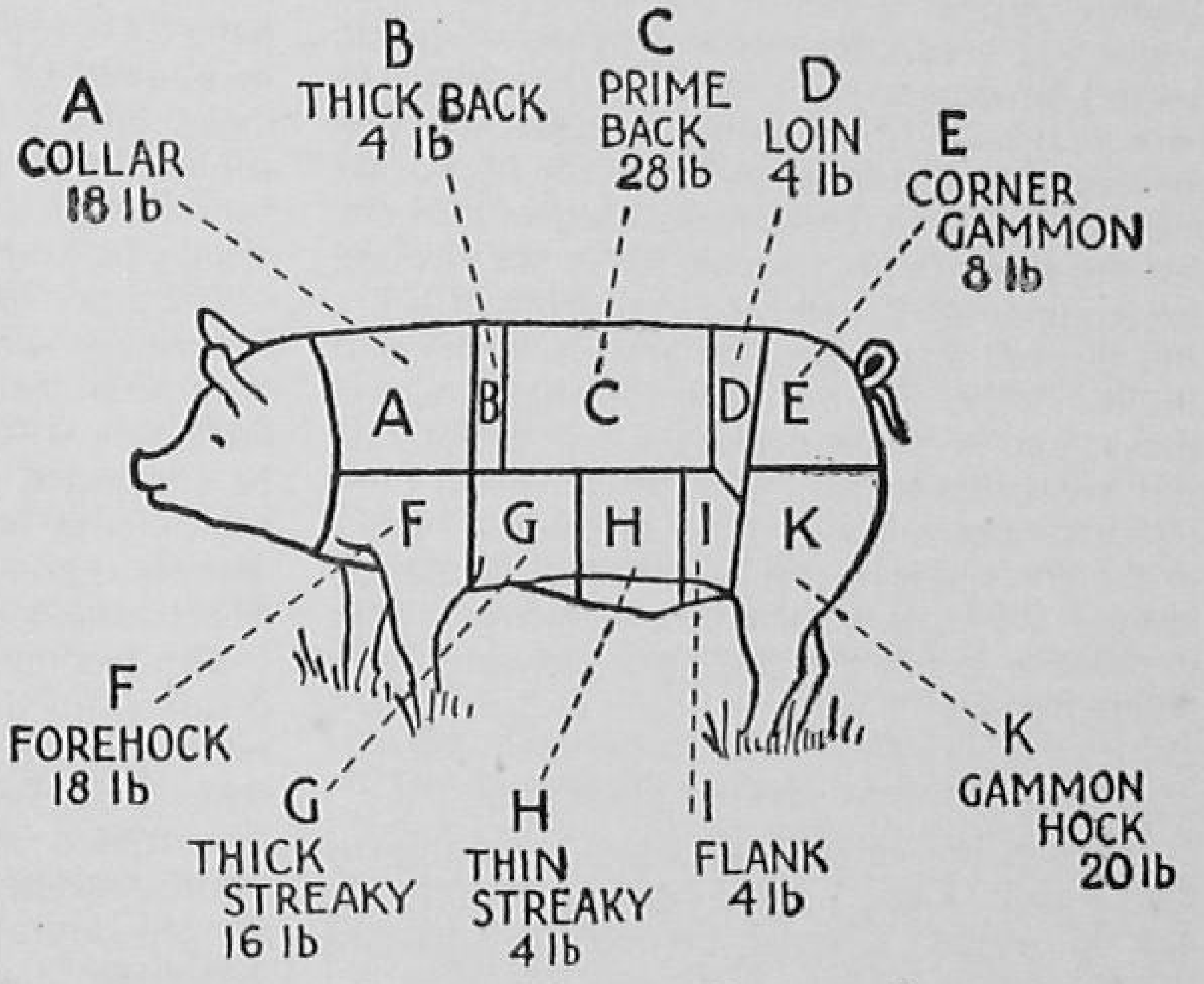
	lb.	lb.	lb.
Barley Meal . . .	35	15	35
Weatings . . .	35	25	25
Flaked Maize . .	20	15	20
Ground Wheat .		35	
Meat Meal or Whalemeat Meals .	5	5	
Ext. Soya Bean Meal.	5	5	
Skim Milk . .		12 gals.	

Maize Meal should be discontinued during the finishing period; it tends to produce yellow fat, a disadvantage not shared by flaked maize. Food should be mixed only with sufficient water to mix it and to moisten the food; it should not be fed in a very liquid state. The feeding of swill is dealt with at some length in the section on feeding stuffs. Potatoes should not be fed before the pigs are 50 lb. in weight; they should then be fed cooked, 4 lb. uncooked potatoes replacing 1 lb. of meal. A bacon pig will, if required, eat 8 lb. of uncooked potatoes if such are available.

Bacon Curing. It has been said that every part of a pig can be used except the squeak; this is almost true when considering the large abattoirs where the blood can be used as dried blood, the hair as upholstery stuffing, the small intestine as sausage skins and the stomach and large intestines as tripe. In this section the factory killing and curing process and the home killing and curing process are discussed in separate sections.

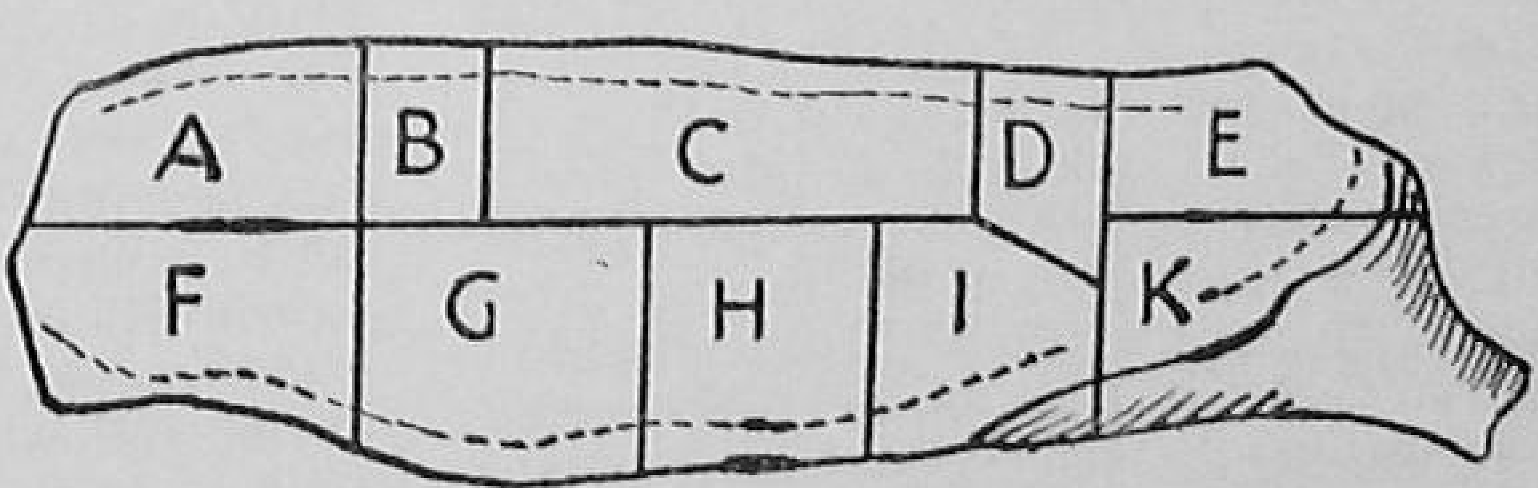
Two Chief Types.

There are two chief types of curing in England and Wales, known as the 'Wiltshire' cure and the 'Midland' cure. In the Wiltshire cure the side (½ carcase) is cured in one piece. In the Midland cure only a part reaches the retailer as a bacon side, the remainder being sold as hams, fore-end, etc. The Wiltshire side (Figs. 18 and 19), is a complete half pig, after the head, tail, backbone, feet, flare, fillet, aitch bone,



STANDARD RETAIL CUTS OF WILTSHIRE BACON IN RELATION TO THE LIVE PIG

FIG. 18



STANDARD RETAIL CUTS OF A WILTSHIRE SIDE

FIG. 19

blade bone and kidneys have been removed. It may be cured in dry salt or cured in brine in a tank. In the Midland cure, the loin is sold as fresh pork, there being a better market for large pork in the Midlands than there is in London and the South. The hams are cured separately and some of the back fat, if very thick, is removed and rendered down for sale as lard.

Killing.

The Factory Process. It is desirable that the

pigs should reach the factory the night before they are killed, so that they are fasted and rested with no journey to undertake on the day of killing. The pigs are taken out of the pens in which they spend the night and are driven into the slaughtering room. Before the pig is actually killed by having a knife stuck into its throat it is rendered insensible by one of two methods. Firstly, the human killer may be used; this has a captive piece of steel which is released with with great force into the pig's skull when the trigger is pressed. Secondly, there is the electric stunner; this has two electrodes which are applied behind the pig's ears for about ten seconds. The skin of that part should first of all be wet with water. The 60–80 volts employed at a high frequency quickly induces insensibility, but the pig will recover in a few minutes, so must be stuck immediately. This is in fact what happens, for as soon as the pig is insensible it is pulled up by the hind leg or legs on to an overhead rail and conveyed to the man who is to bleed it to death. He has a knife 6–8″ long, which is stuck into the pig 1″ on the head side of the breast bone. The knife is inserted with an upward movement towards the heart (the pig is hanging head downwards) and the main arteries are cut. This is an instantaneous process and the pig is left for a few minutes to bleed. The next stage is immersion in a long tank of water at a temperature of 150–170° F. At this temperature the hair is loosened and the pig then goes on to a revolving machine, which rubs off the hair and scaly skin. Whilst the hair is being removed the carcase revolves and when it is removed from this machine most of the hair has been removed from the body, but the face, ears, legs and other parts that the machine cannot touch are scraped by hand with scrapers shaped like a small garden hoe, on the back of which is a hook for pulling off the outside horny part of the hoof.

On leaving this machine a cut is made just below and behind each hock, so that a gambrel (a piece of metal on the coathanger principle, but with a hook at each end of the crossbar) can be inserted. By this the carcase is again attached to the overhead rail and is passed on to the singeing apparatus; this is cylindrical and can be opened down its longitudinal axis to allow the carcase to pass inside into the flame. It remains in the flame for about half a minute during which any remaining hair is removed. This process leaves the carcase discoloured, so it is necessary to brush it and scrape it. It then passes on its overhead rail to the man responsible for removing the contents of the abdominal cavity. This is done by slitting open the carcase down the centre line of the abdomen from the tail to the point where the pig was stuck. Whilst this is being done, two fingers are inserted and moved downwards on either side of the knife, so that by pulling the abdominal wall towards the operator, the wall can be cut without the knife penetrating the intestines. If the intestine is cut, very unpleasant smelling contents are released into the carcase. The rectum is cut out and is removed with the rest of the viscera, the weight of which will cause them to fall forward out of the abdominal cavity. These organs are removed and in due course sorted out so that any usable parts, such as sausage skins, can be retained. The lungs, windpipe, heart and gullet (collectively known as the pluck) are removed from the liver and the gall bladder is separated and discarded. During this process of evisceration the spleen, liver and neck glands are examined for tubercular infection, the neck glands being examined whilst the head is being completely severed behind the ears, except for the backbone, which holds it on to the carcase until weighing has been carried out. The carcase is then divided down the backbone with a chopper, so that it hangs in two halves still on the gambrel. In this state the carcase is weighed, with its legs and feet still on it, and with the kidney, kidney fat and fillets still in it. When this weighing has been completed, the head is cut off, the fillets removed for sausage production and the kidneys and kidney fat removed. The fillets, spleen and various other parts which have been removed are used in sausage production; the remainder of the carcase is removed to the cooling room, which is maintained at a temperature of 40° F. The carcases are usually hung in the cooling room until the following day, when curing begins.

Curing.

The dry cure, with salt and saltpetre rubbed into the carcase is described under the home curing section, where in modern times it more properly belongs. Factory curing is usually done in brine and can be carried out in about 10 days, whereas dry salt curing takes at least 3 weeks. The normal method is to pump brine into the side by inserting the brine needle 20 or 30 times into the side, the brine being squirted through the holes in the end of the needle into the carcase by a pump, in which some 80 lb. per square inch pressure has been established. Whilst this is being done the feet are cut off at the knee and hock, as there is now no need to hang the carcase up by the hind legs. The sides are then put into a large tank, capable of holding perhaps 100 sides and salted in layers as they are put in skin downwards. They are then immersed in brine and remain there for 3 or 4 days. The next process involves stacking them flesh downwards to drain for about 7 days, at the end of which time they are cured. If a more lasting cure is required, the sides will be left in the brine for up to 10 days, but 3–4 days is enough to preserve a side which is to be sold for consumption in under say 6 weeks. Almost all imported bacon is tank or brine cured.

The description of the factory process given may not apply to all factories. Very large factories, employing a large number of men,

divide up the work into smaller individual processes and one man may be responsible for only a part of the work described above as being carried out by one man; just as a motor factory assembles a car part by part on the assembly line, so will a large factory dismember a pig.

Farm Pigs.

Home Killing. The practice of feeding one or more pigs to be killed for use in the farmhouse is much commoner in the north of the British Isles than in the south. The same statement is true of the farm workers' pigs. They are fed commonly to much greater weights than the factory bacon pig of say 200–220 lb. live weight, chiefly because the farming community is fonder of fat bacon and ham than are the town dwellers. Pigs of 300–400 lb. live weight are commonly killed. The pigs should be killed by an experienced man and the pre-killing treatment and the actual slaughtering are as important to success as the subsequent curing of the carcase. The home killing of a pig has the advantage over the factory killing that the pig has no journey to be made and has consequently less handling before it is killed. The disadvantages are that the whole killing and curing process may not be carried out in as cleanly a fashion as in a properly organized factory, but this can be overcome if care is exercised on the part of the owner.

The pig should not be fed for 24 hours before slaughter and should be allowed plenty of water to drink, but if the lack of food causes undue restlessness, a small quantity of food may be given. A pig which has been rested and fasted will produce better carcase than a travelled or fully fed pig. The process of killing on the farm varies a great deal and some pigs are still killed without any stunning prior to the slitting of the throat. If some method of stunning is to be employed, the pig, unless very quiet, should be secured by a noose around the upper jaw so that the head can be held still by securing the end of the rope round a post or a part of the pen. There are several methods of inducing insensibility suitable for use on a farm. The first method is with a pistol using free bullets, but this is not to be recommended since a struggling pig may cause a bullet to be released not into the pig's head, but into some other part of the pig or into someone who is present. The second and most satisfactory method is a captive bolt pistol. This consists of a long piece of captive steel on a spring, which is released by pressing the trigger; these are perfectly safe unless the trigger is pressed when the muzzle end is against any part of the person. The captive piece of steel is driven into the pig's head, the muzzle end of the pistol being held against the head about half an inch above the level of the eyes. Whichever method is used, the throat should be stuck almost immediately.

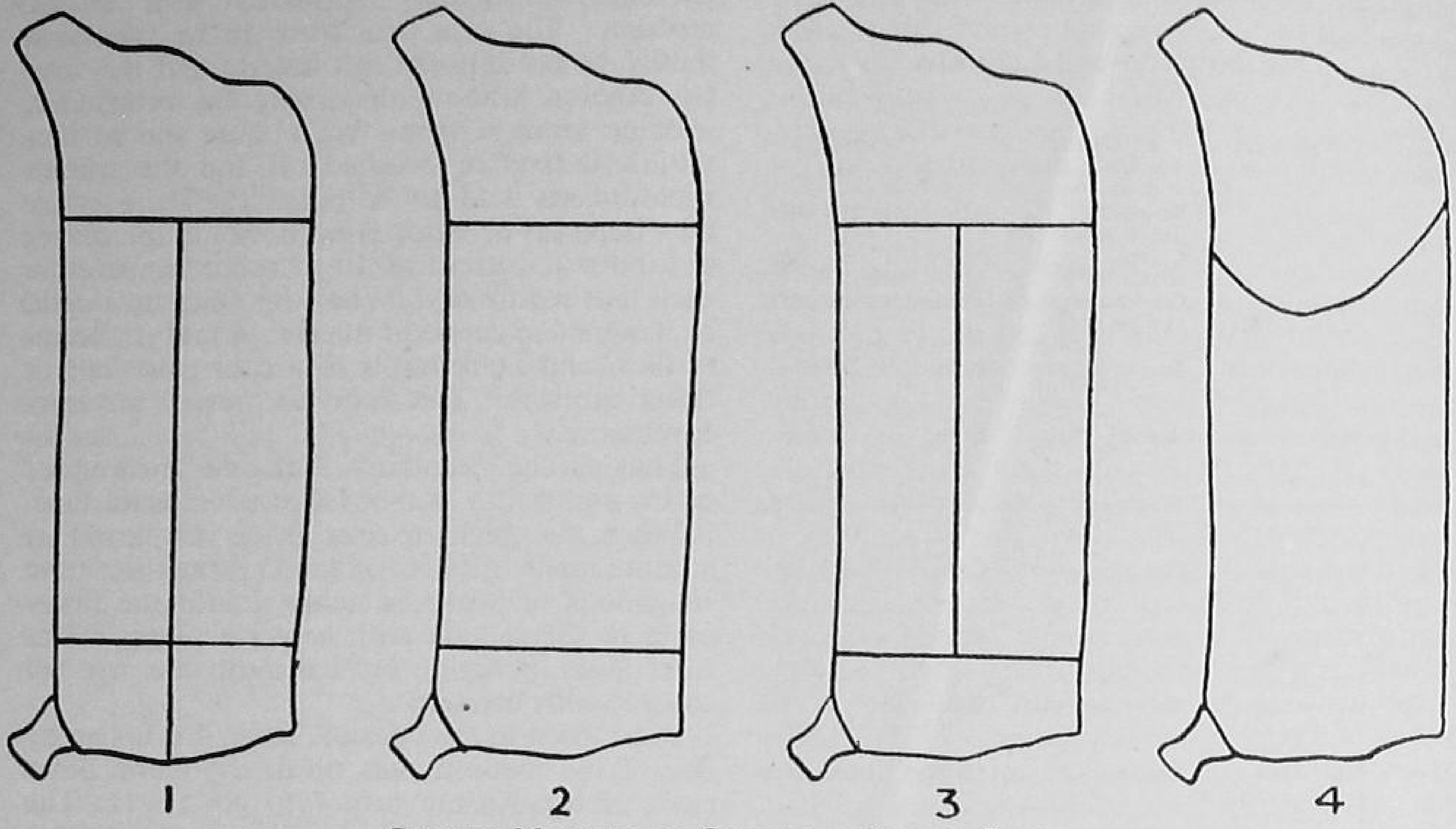
It is essential that the blood be removed from the carcase since blood is a medium in which putrefactive organisms can readily grow and multiply. For some time after stunning the heart will continue to pump blood and remove it from the carcase, hence the necessity for speed. The sticking knife, which is 6″–8″ long should then be inserted about 1″ in front of the breast bone, the pig being laid on its back. The knife should be sharpened on both sides of the point and the pig should be held firmly by the foreleg, since its muscular reactions will cause it to kick during the sticking and for some little time after. The knife must be inserted in the centre line of the pig, otherwise the first pair of ribs, which are close together, may be encountered and this causes the shoulder to be discoloured. The knife is inserted at 45° for a depth of about 4–5″ towards the heart so that the main arteries from the heart are severed. This results in blood gushing out from the wound, indicating that the arteries have been severed. It is advisable to hoist up the pig by the hind legs so that the bleeding process may be satisfactorily concluded.

After bleeding has ceased, the pig is immersed in a large wooden butt or other receptacle in water at a temperature of 145–150° F. Damage is not caused if the water is somewhat hotter than this, but the temperature mentioned is sufficient to loosen the hair. A thermometer should be used, if possible. The hair and coarse scales of skin are removed by scraping with a proper scraper or blunt knife; this must be done thoroughly, any remaining hairs being singed off by burning straw on the carcase. After this a thorough scrubbing and washing will leave the skin smooth and clean. Whilst the carcase is in the hot water the hoof horn may be pulled off by means of the hook on the back of the scrapers.

The carcase is then hoisted to the roof by cutting the back of the hock (as with a rabbit) so that a gambrel or strong stick can be inserted between the tendons and the main part of the legs. A pulley and rope is advisable for this hoisting. When the carcase has been finally washed down, disembowelling takes place. This is done in the same way as has already been described in the factory process.

The carcase is then washed again with cold water and should be allowed to cool until the following day if possible, and for a mimimum of several hours prior to being split either by chopping or sawing down the centre of the backbone, leaving the head attached to one side until after the carcase is weighed.

The methods of cutting up the carcase are many and varied. Some are diagrammatically shown in the four drawings on page 672. The cutting up of a carcase, like carving poultry or the family joint, needs knowledge of the situation of the various bones and joints and practice in cutting round them or through them. Cuts should be clean and for a skilled hand the chopper should be employed rather than the saw. The chief things to avoid in cutting up a side are



COMMON METHODS OF CUTTING A SIDE OF BACON

FIG. 20

(1) having too many cut surfaces, into which bacterial infection may spread and (2) cutting out the bone in too many places, leaving surfaces exposed to infection. Whatever method of curing is adopted, the kidneys, fillet, flare fat, trotters and vertebræ are removed. In the case of rolled bacon, which is not likely to concern the home curer, all the bones are removed. In the four diagrams on this page, which are reproduced from the Ministry of Agriculture's war-time publication " Home curing of Bacon and Hams " (1943), the probable weights of a side from a 200 lb. bacon pig are as follows:—

TABLE XVI.

Cut as in diagram	1	2	3	4
	lb.	lb.	lb.	lb.
Gammon	15	15	15	
Loin	17		17	
Belly	11		11	
Collar	8			
Fore-hock	9			
Middle		28		
Fore-end		17	17	
Spencer or Jacket				43
Ham				17
	60	60	60	60

When the carcase is cut up curing begins. The main ingredients required are salt, saltpetre and sugar, but the last was omitted in war-time. The fineness of the salt is a matter of some argument; coarsely divided salt is probably better than finely divided salt, but whichever is used it must be dry. Saltpetre should be as finely ground as possible and the sugar is applied in the form of brown sugar. The ideal temperature for curing is 40° F. and a suitable room should be chosen; it should have a stone floor for preference, free circulation of air and must be free from all vermin, including flies. A suitable bench is necessary for dry curing or a suitable trough for brine curing. Apart from the necessary knives, chopper and saw, scales for weighing meat and curing agents and a thermometer for noting the room temperature are necessary.

The Ministry of Agriculture recommended for wartime use what was described as their Standard Graduated Cure. It is impossible to describe several different methods of curing in a book of this length, so the author will confine himself to a description of this Standard Cure. The intention was to design a standard cure so that all the meat could be used, the severity of the cure being graduated according to the time for which it is necessary to keep individual portions of the pig. In order to demonstrate the distribution of the consumption of parts of the pig, the table suggested by the Ministry of Agriculture for using a pig is reproduced on the next page. This table (page 673), gives a very good idea of the intention in the mind of the curer before he starts curing his pig. The actual curing process is described later.

The maximum time in salt for any one part should be 5 weeks.

TABLE XVII.

Distribution over 12 months.

Weeks from Killing	Strength of Cure	Use as	From	
1	Uncured	Sausages Small goods	Trimmings and Offal	
		Chops	Spare rib	
		Roast Pork	Blade bone	
2–3	Uncured	Cooked products	Trimmings and Offal	
	Pickle 6–7 days	Hot or cold Salt pork	Fore-hock	
3–8	Lightly cured 3–4 days salt per 1″ thickness	Bacon	Belly	1st side
8–16	Medium cured 5–6 days salt per 1″ thickness	Bacon	Loin	1st side
16–24	Well-cured 7–8 days salt per 1″ thickness	Boiled ham	Fore-hock	2nd side
	Well-cured 7–8 days salt per 1″ thickness	Bacon	Collar	2nd side
24–32	Well-cured 6–7 days salt per 1″ thickness	Boiled ham	Knuckle end of ham	1st side
	Well-cured 6–7 days salt per 1″ thickness	Bacon grilled	Fillet end of ham	1st side
32–40	Well-cured 8–9 days salt per 1″ thickness	Bacon	Loin	2nd side
40–46	Hand cured 9–10 days salt per 1″ thickness	Bacon	Belly	2nd side
46–52	Well-cured 6–7 days salt per 1″ thickness	Boiled ham	Ham	2nd side

The meat should first be soaked in cleansing brine, a saturated solution made with 13 lb. of salt in 5 gallons of water with 4 ozs. of saltpetre added. This is mixed hot, allowed to cool and in it the meat, which is to be cured, is immersed for up to an hour according to the thickness of the joints—hams longest, loin and belly shortest.

Two 60 lb. sides will produce approximately 100 lb. of meat to be cured after deducting the parts which are to be eaten fresh or made into sausages. This 100 lb. of meat will require 10 lb. of salt and ¼ lb. of saltpetre. The average farm-house pig is much heavier than the standard bacon pig, but will require salt in the same proportion (1/10 of the weight of the meat). The very small quantity of saltpetre is difficult to mix and care should be taken in doing this; if necessary 4 portions of salt should be mixed separately with 4 portions of saltpetre and then the whole mixed together. The old practice of rubbing in saltpetre by itself, which occasionally led to trouble, is thus avoided.

After the cleansing brine has drained away, the skin surface should be thoroughly rubbed with the curing mixture, which should then be lightly rubbed into the flesh side, more of the mixture being used for the thicker cuts. Next prepare a salt bed 2″ thick and press each cut into it skin side downwards and sprinkle lightly with curing mixture. The whole is then covered with 1–2″ of salt, which must be packed tightly against the sides of each cut. After 5 days the spent salt is removed, the cuts being repacked as before, having been freshly sprinkled with curing mixture. The cuts which are to be used first should be put into the salt last, so that they can be removed without disturbing the remainder.

After removal from the mixture the surplus salt is scraped or brushed off and the surface wiped to get it as dry as possible. The cuts are then hung up by string from hooks in the ceiling in a normal current of air at room temperature until thoroughly dry. When dry each cut should be wrapped in calico or muslin, to prevent access of flies, and hung again in a cool place out of direct sunlight. This helps to prevent rancidity developing.

That is the Standard War-time method of curing and it may well be followed in peace-time.

When the pickling method is employed, a mixture made of 50 lb. of salt, 5 lb. saltpetre and 20 gallons of water is pumped into the fleshy parts of the carcase with a pickle pump. This is followed by laying out the meat in a salt bed covered with dry salt.

In addition to the sides of bacon, divided up by one of the methods described, the many other parts of the pig are turned to good use. The head produces meat which is usually made into brawn. The composition of brawn varies, but almost invariably includes the ears, tongue, snout, cheeks, lips and such other meat as can be removed from the head, after it has been boiled to free the meat from the bone. The lungs, heart and liver (minus the gall bladder) can be mixed

TABLE XVIII.

Offals	lb.	ozs.	Totals lb.	Totals ozs.	Per cent. of Live weight
Blood	7	—			
Sweetbread		5			
Diaphragm		14			
Lungs and Windpipe	1	7			
Heart		9			
Liver	4	12			
Spleen		3½			
Pancreas		4			
Kidneys		13			
Flare	3	6			
Caul fat		5			
Gut fat	2	5			
Gullet		2			
Empty stomach	1	1			
Empty intestines	5	8			
Hooves and hair	1	4			
Gall bladder		6	30	8½	15·3
Loss Content of guts, evaporation, etc.			19	7½	9·7
Carcase Cold carcase			150	—	75·0
			200	—	100·0

with onions, bread crumbs, internal fat and seasoning and cooked in the oven. The spleen, fillets and any trimmings of lean meat are mixed with half their weight of fat and half their weight of bread to make filling for sausages. The skins of the sausages are obtained from the small intestine. Blood can be collected and used in the production of black puddings. Factory blood is more commonly dried and sold as dried blood as a fertilizer. Any surplus fat is rendered down to make lard, the gut fat being normally treated separately on account of the risk of unpleasant flavours from it spoiling the best lard from the other fat. The inner lining of the stomach can be removed and cooked as tripe; the lining of the large intestine may also be cooked as tripe aft the intestine has been turned inside out and t lining removed. The pig's feet (trotters) and t are normally boiled and eaten. The kidneys a eaten as a breakfast dish. In factories the surpl bone and hooves are sent to the glue and fertiliz manufacturers, the hair is used as upholste stuffing and the blood as a fertilizer.

The table on page 673 shows the weights of t various parts of a 200 lb. pig when slaughtere

Of the 150 lb. of carcase the head will wei 13 lb. 12 ozs., the tongue 12 ozs., fillets 1 lb. 8 oz trimmings, fat and tail 5 lb. 4 ozs., bones a trotters 8 lb. 12 ozs., a total of 30 lb. T remaining 120 lb. makes two 60 lb. sides.

CHIEF DISEASES AND AILMENTS

The more important diseases and ailments of the pig are discussed together with particulars of prevention and cure. Swine erysipelas, Swine fever, foot and mouth disease, worms, digestive troubles, lice and rheumatism.

SWINE ERYSIPELAS.

Caused by a Bacillus.

SWINE erysipelas is not one of the notifiable diseases and need not, therefore, be reported to the police. It occurs throughout the British Isles at all seasons of the year, but particularly in late summer. It is caused by a bacillus, which may gain entry into the body through food, water or wounds; the bacillus may survive for a long time in soil or in dung. Pigs, particularly fat ones, are the most usually affected animals, though sheep, horse and man may be affected. Young pigs do not as a rule contract the disease.

There are three fairly common forms of the disease: (a) mild, (b) acute, (c) chronic.

The mild form produces a high temperature and loss of appetite; the animal is ill for a few days and then either recovers or becomes a chronic case. A sharply defined rash, dark red or violet in colour, may be present particularly on the chest, back, neck and thighs. The patches of rash are 1–2″ across.

The acute form produces a very high temperature, the onset of the disease is very rapid and death usually occurs in a few days. The rash may be present as in the mild form.

The chronic form may be chronic from the outset or may follow either the mild or the acute form. The affected pig is unthrifty and sometimes has a cough; it grows and fattens slowly and lies on its breastbone and not flat on its sides as is normal with pigs. Most affected pigs eventually die and in any case are uneconomical to keep. The characteristic rash may be present as in the mild and acute forms. In many cases of all three forms of the disease the rash may be absent.

It appears that swine erysipelas may be latent in a herd of pigs and flare up at intervals and some premises seem to be particularly liable to the disease.

The preventive measures are (1) Isolation of all purchased stock for a week and breeding of your own stock where possible. (2) Destruction of infected carcases by burning in lime. (3) Inoculation with the recommended serum to give immunity to non-infected pigs. This policy should only be adopted where either the farm or the surrounding district is infected and should not be a regular practice.

The curative measure consists of giving injections of serum, using larger quantities than are employed as a preventive dose; this practice is effective in curing 75 to 90 per cent of cases treated.

No pig in ill-health should be sent for slaughter from a farm on which infection is present. Such ill-health may be the start of the disease and by the time the pig is slaughtered discoloration may have set in, in which case the carcase will be condemned.

On farms where the disease has previously occurred, a protective vaccination may safely be given annually, in the spring.

Caused by a Virus.

Swine Fever. Swine fever is a contagious disease and must by law be notified to the authorities. When an outbreak is notified the Ministry of Agriculture prohibits the movement of pigs in the locality with the exception of healthy, fat pigs, which may be moved under licence for immediate slaughter. The disease only affects pigs and is caused by a virus, a living organism that is so small that it is invisible even under the microscope. Young pigs are the most commonly infected and the owner should suspect the presence of the disease if a number of pigs are dying or looking unhealthy, particularly when this occurs in the young pigs only. The sick pigs will suffer from lack of appetite, shivering and possibly vomiting. A purple rash may be present on the skin of the ears and belly. Death usually occurs in from 10–80 days, the largest number of deaths occurring at 15 days. The pigs suffer from great thirst and a preference for eating bedding and filth rather than their normal food. In some cases the most noticeable symptoms are inflammation of the lungs and other usual symptoms of pneumonia. The average death-rate is very high and the disease must be looked upon as the most serious of pig diseases in this country.

Needless to say, newly purchased pigs should be kept under careful observation for 10 days after their arrival on the farm; by the end of this period any infected pigs will show symptoms of the disease, because the incubation period (the period between infection and the appearance of symptoms) is only about 5 days and the disease if present would certainly be noticeable in 10 days.

The disease is spread by the movement of pigs or by the movement of dung or other infected material from one farm to another.

The best preventive measures are (1) To refrain from buying pigs and wherever possible to breed them at home. (2) To isolate any purchased pigs for a month. (3) To isolate any sick pigs immediately. (4) To reduce rats. (5) To refrain from hiring your boar to other farmers.

If the Ministry confirms an outbreak of Swine fever, the non-infected pigs may be given preventive serum as a protection and may then be mixed with ailing pigs. This avoids the very difficult task of isolating infected pigs, a measure which necessitates having separate attendants for infected and healthy pigs, separate feeding

utensils and so on. When all this trouble has been taken, it is still possible for the disease to be spread round the farm by rats.

The pig owner should never attempt to decide for himself whether Swine fever is present or not; being a notifiable disease he must report it on suspicion.

Symptoms.

Foot and Mouth Disease. Foot and mouth disease is extremely contagious and must by law be notified to the authorities. It is caused by a virus, an organism so small that it can neither be seen under the microscope nor collected in a porcelain filter. All cloven hoofed domestic animals are subject to the disease and so are some wild animals such as the hedgehog; rats spread the disease mechanically but do not contract the disease.

Infected animals become dull and go off their food and have a higher temperature than normal. This is followed by lameness and slavering at the mouth, the latter symptom being less noticeable in pigs than in cattle. Later, blisters appear inside the mouth, round the coronet and between the claws. Pigs with the disease sometimes exhibit blisters on the skin of the body.

If the disease is allowed to run its course animals will recover in all but a small percentage of cases. The farm stock of most countries exhibits the disease. In this country not only are the diseased animals slaughtered, but any animals which have been in contact with them are also destroyed; the carcases are burnt.

The spread of the disease is not fully understood and outbreaks appear unexpectedly and frequently cannot be attributed to any particular source of infection.

Under the Foot and Mouth Disease Order (1928), any stock-owner having infected stock must report immediately to the police.

As already explained the disease is not always fatal and as in the case of cattle, a large proportion of the animals would recover, but they would not thrive and would be uneconomical to keep. The accumulative loss to the country would be far greater if the disease were allowed to run its course than is the case with the policy of slaughtering all affected animals and all those which have been in contact with affected animals. Livestock owners are compensated for the loss of the animals slaughtered.

Worms.

Round Intestinal Worm. This is of very common occurrence in pigs and if not dealt with adequately causes the animal to be inferior and the outcome is very uneconomical live weight increase for the amount of meal consumed. The worm is round and white measuring up to 12″ in length by ¼″ thickness. Worms cause the most serious damage to young pigs, from which, however, it is fortunately fairly easy to remove them. Scores of these worms can be found in badly infested pigs and may be present in such large quantities as to cause a stoppage of the gut.

Life Cycle.

The life cycle of the worm begins when the eggs are laid by the female worm living in the intestine of an infected pig. The eggs are laid in thousands every day and appear in the solid excreta of the pig. These eggs are invisible to the naked eye and do no harm when they first appear; they take some 2 or more weeks before they are sufficiently developed to infect other pigs. When this development has taken place, the egg may be picked up by another pig, pass into the intestine and hatch out there. It is not content, however, to develop there; it then bores through the intestinal wall and gets into the blood stream and is carried to the lungs. At this stage symptoms of infection may take the form of a cough. From the lungs the young worm gets back into the mouth by passing up the windpipe and is then swallowed. Reaching the intestine for the second time it grows to maturity, eventually laying eggs in about 2 months. Whilst present in the intestine the worm interferes with digestion of food and causes the pig to make uneconomical use of its food.

There is no means of destroying or expelling the worms until they reach the intestine for the second time, even though they may be doing considerable damage in the lungs. The young worms should be cleared out of the intestine during the two month period before they become sexually mature. The best time to eliminate them is, therefore, 3–4 weeks after the coughing stage, when they are in the lungs.

Cleanliness in the sties is important and droppings should be removed regularly to a heap out of reach of all pigs. Open-air pigs should be changed to a fresh run as often as possible, but this is complicated by the fact that ground on which pigs have been run cannot be considered free from infection for three years.

In order to prevent infection of young pigs, the expectant sow should be treated for worms a fortnight before she is due to farrow and then thoroughly washed down, particularly around the udder. She should then be put into her farrowing quarters which should have been throughly cleaned out and washed down with boiling water, so that the young pigs will be born in clean surroundings from a mother cleared of worms. It should be noted that the worm's eggs are not killed by strong disinfectant or by lime, nor by cold, nor by drought.

The Lung Worm. This is a small worm 2″ long. It inhabits the small tubes of the lungs where it lays many eggs which eventually reach the soil. The most noticeable symptom is a cough. The newly hatched worms are taken with soil into the gut of an earthworm where they develop to the next stage. The worm is eaten by a pig which thus becomes infected. Infestation can

thus be avoided by rearing pigs on clean, concrete floors. Ground which has not been used for pigs is safe, since the earthworms consumed will not be worm infested. No medicinal treatment for infected pigs is known. If infection appears, the pigs should be moved on to a concrete floor, where, in the absence of earthworms, further infection is impossible.

Two Drugs Used.

Pigs should not be dosed for worms until they are at least 6 weeks old They should be dosed at 8–10 weeks old if they show signs of infection and a somewhat larger dose should be given 6 weeks later; this should ensure the freedom of fattening pigs from worms. The two drugs used for this purpose are santonin and oil of chenopodium, the latter being the cheaper. The dose of santonin is 5–10 grains as prescribed, according to the size of the pig. It is a poisonous substance and is, therefore, followed by a dose of Epsom salts six hours after administration, in order to remove it from the pig's intestine. Santonin can be given in the food. Oil of chenopodium is given following a 14 hour fast; 5 per cent oil of chenopodium should be mixed with 95 per cent castor oil or with 45 per cent linseed oil and 50 per cent castor oil. The dose of this mixture is 1 oz. for 20–35 lb. pigs and 2 ozs. over 35 lb. The mixture should be administered to each pig separately. The method of dosing the pigs is described here because the administration of a liquid dose to a struggling pig is not easy unless properly carried out. An assistant should be seated in or just outside the sty. Grasping the pig by both ears, it is seated on its haunches, its sides being grasped between the knees and the grip on the ears retained. The administrator of the dose inserts a square 2″ × 2″ stick crossways through the pig's mouth. The stick has a hole through it and the dose is poured through the hole, the pig's mouth being held open by the stick.

Minor Ailments.

Digestive Troubles. A change of rations, or particularly in these days the feeding of unsuitable rations, may cause digestive trouble in pigs of any age. Changes of rations should be made gradually and unsuitable food, if the cause of the digestive trouble, must be discontinued. If the cause is overfeeding, omit a feed, reduce the quantity for the next two feeds and then build up the required ration again. Simple correctives (V. C. Fishwick, 1944) are: (1) Grazing for at least 2 or 3 hours daily for a few days. (2) The use of a mixture of 3 parts Epsom salts and 1 part nitre, given at the rate of ¼ oz. for pigs under 80 lb. live weight and ½ oz. for pigs over 80 lb. live weight; the mixture can be given in the food.

Mange. This is first evident by a scabby condition of the skin, particularly on the neck and ears. The affected pigs should be scrubbed with warm, soapy water and then rubbed with a mixture of 5 parts milk of sulphur and 20 parts codliver oil. This should be done twice weekly for as long as necessary.

Lice. These must be got rid of at once, because the irritation caused by them hinders the progress of the pig. Dress the lousy parts (usually the head, ears and back) with linseed oil or refined mineral oil or motor oil and repeat in 10 days.

Cramp, Rheumatism, Etc. Where the troubles are common, the cause is either an error in nutrition or bad housing. Where a normal ration adequately supplied with minerals is fed, nutrition is unlikely to be the cause. Where the ration is suspected, however, codliver oil should be given at the rate of a teaspoonful to sucking pigs, one tablespoonful from weaning to 50 lb. live weight and two tablespoonsful over 50 lb. live weight. Damp housing will cause cramp and stiffness in pigs. The remedy is obvious.

LABOUR, CAPITAL AND RETURNS

The importance of skilled labour is stressed. An estimate is given of the capital required to start a pig farm; the purchase price of stock and buildings is discussed and an estimate is made of the working capital required for such things as food and wages until the first pigs are sold. Details are given of how to calculate the estimated sales and returns from a pig unit.

LABOUR.

Pigs Repay Care.

ON the majority of farms in this country a comparatively small number of pigs is kept and the animals are tended by a stockman who has other stock in his charge—for example, on many dairy farms the assistant cowman has charge of the pigs. There are, however, a few farms on which the pig unit is sufficiently large to justify one or more wholetime pigmen. Pigs repay care and attention especially when young and success or failure in rearing a litter of pigs is largely due to the attention given by the pigman.

The number of pigs which can be cared for by one man depends on the system employed. In a herd where the object is the production of weaner pigs, the labour will be a fraction of that on a farm where the chief object of production is 200 lb. bacon pigs. In a well arranged unit a man and a boy can look after 30 sows and their progeny until they are marketed as baconers.

The Good Pigman.

A good pigman must be conscientious, because the job entails long hours in all weathers, with farrowing sows to be attended to, often during the night. He must be intelligent because he must be able to ration the food correctly to the pigs. He must be observant, so as to detect the first signs of ill-health in a pig, the first sign of oestrum in a sow, whether or not the pigs clear up all their food or whether some should have their rations cut down and so on. He must be patient, since the handling of pigs is often a rather exasperating business. Patient and kind handling of the stock invariably pays good dividends.

The pigman should be able to make a good job of castrating the young pigs at 4–6 weeks old, and on farms where pigs are killed and dressed for a local pork trade he must be able to kill and dress the porkers. Any premises used for this purpose must be licensed.

One of his most important functions is the weighing of fattening pigs fortnightly, or weekly later on in their fattening period. This must be done very carefully with the minimum of disturbance to the pigs concerned. Weights should be entered up on some sort of record sheet designed to show the progress of individual pigs. This provides an excellent check on the suitability of rations, health of the pigs, litter weights from different sows and different boars. The records are useless, however, unless complete reliance can be placed on the pigman's figures. These records should be kept for reference and the pigman encouraged to take an interest in them and to follow through the records of sows and the effects of different rations. He may often notice points which have escaped the owner. The minimum amount of weighing for bacon pigs should be at weaning and monthly thereafter.

STARTING PIG PRODUCTION AND THE CAPITAL REQUIRED.

Good Planning.

The first essential is to have a carefully considered plan. The local market must be studied and full and mature consideration given to the advisability or otherwise of adhering to the local breed. The distance from the market is important, not only from the point of view of the cost of transport, but because travelling is bad for stock prior to killing or sale. It was not generally possible before the war to produce entirely for the pork or bacon market. There was little demand for pork pigs during the summer. Consequently, in herds where the pork market was the primary object, a considerable proportion of the pigs fed in the summer was either sold as stores or fattened for bacon. On the other hand those who were selling their pigs under contract to the bacon factory had of necessity to produce rather more pigs than they actually needed to allow for accidents; thus they had a small surplus which was sold either in the store market or the pork market.

The following table shows the categories in which pigs were marketed prior to the war:—

TABLE XIX.

	(Weighed before feeding on farm) Live Weight	Dead or Dressed Weight
Porkers	90–115 lb.	60–80lb.
Porkets	115–145 lb.	80–100 lb.
Cutters	145–190 lb.	100–130 lb.
Class 1 Bacon	195–221 lb.	140–167 lb.
Class 2 Bacon	222–235 lb.	168–180 lb.
Class 3 Bacon	236–270 lb.	181–210 lb.
Class 4 Bacon	Over 271 lb.	Over 211 lb.

Having fixed upon location, breed and object of production, the next step is to decide on the size of the herd. The starting figure for this should err on the low side rather than the high side, bearing in mind the accommodation available and the fact that it is economical in labour to have a 'one man unit' or 'two man unit' and so on. On a farm devoted solely to pig production the herdsman has no employment except that concerned with the pigs, so he should be given the

maximum number that he can look after. The number of pigs which one man, with the assistance of an intelligent boy, can look after is the unit including 30 sows and their progeny; this will mean that two boars, 30 sows, and between 200 and 300 other pigs are permanently on the farm, assuming that with regular breeding an average of five sows farrow each month, that bacon pigs are marketed at 7 months and that a small proportion is sold as pork at an earlier age. It should be borne in mind that casual labour can usually be obtained if necessary for such jobs as fencing, repairs to buildings, manure carting, and the removal of pigs to market.

The disadvantage of the farm devoted entirely to pigs should be pointed out before the question of capital is discussed. This type of farm has not only to pay the whole of its labour bill from the returns from the sales of pigs, but is also dependent on outside sources for the purchase of straw and for the disposal of manure, in contrast with the mixed farm, which can provide the pig unit with straw and at the same time profitably use the pig manure in the production of crops. Pigs are liable to suffer from disease; an outbreak of Swine fever may paralyse the specialized pig farm for a year or more.

Difficult Topic.

Capital Required. No book on pigs would be complete without some attempt to estimate the capital required to start a pig unit. The subject is difficult in normal times, because the capital required on a purely pig farm, where the necessary buildings have to be erected, is very different from that required on a farm where the existing buildings are employed to house a small unit of 5–10 sows. The subject is even more difficult at present, when the future is so uncertain.

Pig houses cannot be built of new materials unless a permit is obtained and it is practically impossible to obtain such a permit. Any mention of the cost of a new pig house would therefore be in the realms of fantasy. A pig house may, however, be built of secondhand materials erected with the farmer's own labour and it is such an enterprise that the writer has in mind when housing costs are mentioned in this section.

The cost of labour has altered between the writing of this section and its dispatch to the publisher; it may well alter again before the book reaches the reader. The price offered per score of bacon sold, as mentioned in this section, is already out of date.

Let the figures (early 1946), which are used in this section, be accepted with reserve and altered by the reader when necessary.

Only one type of pig unit has been considered and that is one where the buildings have to be erected and the unit brought into existence solely for the production of pigs. To discuss other systems as well would make for confusion and for unjustified space in this book.

Planned Stock.

Stock. It has been pointed out that pure-bred pigs should, if possible, be used in bacon or pork production because this provides an alternative market for the progeny as breeding stock and also enables herd replacements to be home-bred. The prospective pig breeder, when he begins to buy his breeding stock, will find that a very large sum of money is required if all the breeding stock is purchased from pedigree herds. It will be cheaper for him to buy only sufficient pedigree gilts from which to select his future breeding gilts and to buy non-pedigree, but pure-bred gilts to make up the balance of his breeding herd. If the pedigree gilts purchased are in-pig their progeny will be in the herd and due to farrow in about 12 months, so that the increase is very rapid. As the pedigree stock increases in number, the number of non-pedigree sows can be reduced. Some of the pure-bred gilts may of course be mated to a boar of another breed if so desired.

If it is intended to have a 30 sow unit the prospective pig-keeper will be well advised to buy half of these as near farrowing as possible and the other half old enough to serve. In this way he soon gets some returns in the form of young pigs, he staggers the farrowing dates and at the same time buys all the gilts when they are old enough to show their faults. Useful commercial in-pig gilts can be purchased for about £25 each (early 1946 prices) and the younger gilts will cost £15–£20. One boar must be purchased to mate immediately to the younger gilts and he is unlikely to cost less than £25, so that a cheque for £700 must be written for breeding stock. It is as well to point out here that the pre-war price of such gilts would have been £12 and £8 respectively, with £10 for the boar—a total of £315.

Buildings. The building situation is so difficult at present that it is impossible to write definite about cost. Farrowing ranges were erected at Wye before the war, at a cost of £20 per pen and it was possible to construct cheaper, but less economical pens before the war.

Costs.

The cost of farrowing sties is very much higher at the present time and for the purposes of this section the author is going to assume an average cost of £30 per sty. Each sow will need a farrowing sty for two three-month periods during the year, so that for a 30 sow herd 15 farrowing sties will be required, with perhaps two to spare in case there is a period when more than the regular number of sows is farrowing. The pigs after weaning must be housed in a feeding house and as about 180 pigs will have to be housed, it is unlikely that this will cost less than £800 at present prices. Improvised houses for boars and for young growing gilts constructed of any available make-shift material may perhaps cost a

further £100. This makes a total of £1,410 for all accommodation. Fencing, if it is considered necessary, may cost about £100 and a horse and cart a further £80. Small equipment such as troughs, food bins, weighing machines, veterinary appliances, office stationery, buckets, forks, shovels, brooms, wheelbarrow and hurricane lamps may well cost a further £200, making the total initial capital:

	£
Gilts and Boar	700
Accommodation	1,410
Fencing	100
Horse and cart	80
Small equipment	200
	£2,490

During the first few months of a purely pig-keeping venture there will be no returns; this is unlike dairy farming and some other farming activities where some return is obtained immediately to help in defraying such expenses as those of labour and stock food. Consequently, a considerable amount of working capital is necessary to carry the farm through the first six months and somewhat less during the second six months. The largest item of this working capital is for feeding stuffs.

From the information already given in this book it is an easy sum to calculate the required quantity of food for this unit for six months. Should the author set this out in detail, it would deprive the reader of an instructive exercise, so that only the total of 32 tons is given here. At 1946 prices this will cost £15 per ton, making a total of £480. Straw costing £30 and oats for the horse costing £15 will also be necessary during this period. The pigman at £4 per week and his assistant at £2 per week will cost £156 and with rent at £20 and sundries at £40 we reach the following for working capital for the first six months:—

	£
Pig food	480
Straw	30
Oats for horse	15
Labour	156
Rent	20
Sundries	40
	£741

During the second six months a similar calculation shows food for the increased number of pigs to be 63 tons at £15 per ton which is £945. Straw and horse food once again total £45, labour £156, rent £20 and sundries £40, making a total for the second six months of:—

	£
Pig food	945
Straw	30
Oats for horse	15
Labour	156
Rent	20
Sundries	40
	£1,206

The receipts during this period will be 15 litters sold as bacon with 7 pigs per litter or 105 bacon pigs. It would be unwise to predict that the gilts would rear more than an average of 7 pigs per litter. These 105 bacon pigs will sell for 26/– per score at present prices and their weight will be about 8 score. This represents a selling price per head of £10, of £1,050 altogether. This may be deducted from the capital required to start this venture, so that the final figures for capital required are as follows:—

	£
Initial Capital	2,490
First six months' expenses	741
Second six months' expenses	1,206
	4,437
Less 105 bacon pigs at £10	1,050
Total Capital	£3,387

This figure looks incredibly large, but it should be borne in mind that the buildings have all been built out of this sum, whereas improvised buildings or adapted farm buildings would cost much less. If the owner were prepared to work on the unit himself he could dispense with some of his staff and employ only one man at £4 per week instead of the man and boy allowed for at £6 per week.

Normal Profit.

Profit and Loss. The figures which have already been stated for the capital required to start this pig unit, coupled with the details of rations, which have been given, make it possible to work out some idea of the probable profit in the course of a year. The buildings which were erected would have to be depreciated at the rate of 10 per cent per year to cover repairs and depreciation. The horse and cart, the troughs and small tools and the fencing would have to be depreciated by a similar figure. The depreciation of the breeding stock, if it were always to be purchased, would be very heavy at present prices; a gilt for example would depreciate from £25 to £7 in about 3 years, representing an annual depreciation of £6 per gilt or £180 for the whole herd. If on the other hand all gilts after the initial purchase were home-bred, they could be produced for about £10 and sold for £7 in about 3 years, making an annual depreciation of only £1 per head or £30 for the whole herd. The reader will realize, therefore,

the impossibility in this book of giving anything further than an idea of how to work out the profit and loss, the actual working out depending on the depreciation to be charged for buildings, the amount of work done by the owner and the depreciation to be charged for the breeding stock. It is likely, however, that the normal profit on a small, one-man pig unit will be small, possibly under £100 per year. Expansion, there-therefore, must be the keynote, coupled with economical feeding, improvisation in housing and home breeding of the breeding gilts.

Expenses.

Costs of production. Reliable costs of production of pigs on a mixed farm are not very difficult to calculate, despite the fact that so many of the items used in the production of the pigs are used in the production of other saleable goods from the farm. Under this heading are buildings, manual labour, straw, horse labour, postage, stationery, expenses of the owner in reaching sales and markets and insurance. These items of expenditure can be allocated to the pig production branch of the farm in various ways. Manual and horse labour can be charged to the pigs from the men's time sheets, which will show the number of hours they are employed on the pigs and in the case of the horseman's time sheet this will also show the number of hours the horses were employed in the pig section of the farm—carting food, straw, pigs to market and so on. The remaining items can all be put together and are commonly charged to each department of the farm in proportion to the manual labour bill for that department; for example, if the total labour bill on a farm is £1,000 per year and the total labour bill on pigs is £100, 1/10 of the sundry items mentioned should be charged to the pig production.

A farm which is dealing solely with pigs has an easier costing problem because all business expenditure incurred by the owner is chargeable to the pig production. Buildings depreciate and this must be charged to the pigs, labour is employed solely on pigs, a horse is kept solely for carting in connection with pigs, straw is purchased solely for pigs and all the office, insurance and marketing expenses must be debited to the pigs. The question of the pros and cons of charging interest on capital is too involved to discuss here, but in the case of the farm devoted entirely to pig production, the interest on capital if charged must be debited to pig production.

The reader will appreciate, from what has already been said on this subject, that concise and definite tables showing the cost of production of a weaner pig, a pork pig and a bacon pig are difficult to compile. The best that the author and reader can do is to study together the method of building up such costs, so that they can be applied to any particular set of circumstances which arise in practice.

Before entering into costs and returns in detail, it is as well to state again that, if profits are to be made from pig-keeping, efficient management and careful consideration of production costs are absolutely essential—without these the pig-keeper would be better employed in other ways.

Economy.

Food. The pig is fed almost entirely on concentrated foods which are expensive to buy or to produce. No part of its ration consists of hay, or straw as in the case of cattle and although the pig puts on flesh very economically per pound of food given to it, the cost of the food is very high and represents more than half the total cost of production of any type of pig. Economy in feeding, therefore, is of primary importance.

As a result of careful records at Wye, Fishwick found that to produce a pork pig of 120 lb. live weight three cwt. of meal was required and to produce a bacon pig of 200 lb. live weight six cwt. of meal is required. As a useful exercise this may be checked by the reader from the table of weight progress and meal consumption on page 686. Fishwick also states that a sow rearing two litters per year of 16 pigs consumes about 22 cwt. of meal in a year, including the small amount of meal eaten by the young pigs before weaning. If this meal consumption is calculated per pigling at weaning, it shows the amount to be debited to the weaner as 154 lb.

Gilts, states the same author, consume ten cwt. of meal between weaning and the time they are mated, when their subsequent meal consumption is included with that of the sow. Boars will consume between 15 and 20 cwt. per year.

Different Methods.

Buildings. The different methods of housing pigs are so many and so varied that it is very difficult to arrive at a reasonable figure of cost, particularly in view of the uncertainty of future prices and the unknown development of pre-fabrication when applied to pig houses. New materials for pig housing may well be on the market in a few years. If we take one example of wooden pig buildings especially erected for the purpose and built in the normal days before the 1939–45 war, an idea of cost may be obtained. Buildings at Wye, erected to be suitable for farrowing or fattening cost £20 per pen. If interest at 5 per cent is charged and depreciation and repairs at 10 per cent, this means that the use of a pen for a year costs 60/–. A simple calculation, based on the time for which any one class of pig is a tenant, shows that the charge per sow per annum for her two three-month periods of tenancy with her litter is 30/–. Baconers also occupy the pen for six months, but it will hold about six of them, making the charge per bacon pig 5/–. Porkers occupy the pen for only three months, which costs 2/6. These figures are obviously only a guide and the cost in Danish

houses, or in temporary shelters made of straw bales or in fold houses must be calculated separately, but on the above lines.

Labour. As previously stated the amount of labour expended depends on the system of management and on the kind of housing employed. It will be least where all the pigs are housed indoors, but the progress of the pigs and the losses due to ill-health will probably more than offset the economy in labour.

Labour costs are bound to be expensive in pig-keeping owing to such jobs as food mixing, soaking, feeding small numbers of stock in each pen, castration, marketing, farrowing, weighing. Much labour is overtime and consequently the weekly wage of the pigman appears high when compared with that of the ordinary farm worker. Wages at present are much higher than before the war and may well be higher still, but in order to arrive at a working figure, let it be assumed that a pigman at £4 per week will look after 40 sows; this means an annual cost of £6 per sow.

Depreciation. The estimated life of a boar at Wye is two years. The useful life may be much longer, but at the end of two years his daughters will be coming into the herd, so another boar will have to be purchased.

A £23 boar will be worth £8 to sell at the end of his two years, making an annual depreciation, therefore, of £7 10s. 0d.

Sows at Wye, which enter the herd as gilts, will stay in the herd for an average life of three years. They have cost, with meal at 15/– per cwt. about £12 when they enter the herd and leave it as fat sows at an average value of £5. This leaves a £7 depreciation spread over three years, or £2 6s. 8d. per year.

Losses and Sundries. Some loss is bound to occur if pigs suffer a check. Some may die through illness and sundry expenditure has to be charged up. With all these hazards included, the costs in the Wye herd have been calculated to be as shown in Table XX.

In the table (*see* below) the weaner pig has been assumed to cost £2 (the cost of the sow divided by the number of pigs weaned in the year). Food has been charged at 15/– per cwt. The cost of litter has been disregarded in view of the value of the resulting manure.

Table XX.

	Boar for 1 year			Gilt from weaning to mating			Sow for 1 Year			Baconers sold at 200 lb. Live weight			Porkers sold at 120 lb. Live weight		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d
Food	15	0	0	7	10	0	16	10	0	4	10	0	2	5	0
Labour	2	12	0		14	0	6	0	0		12	0		6	0
Buildings	2	0	0		10	0	2	0	0		5	0		2	6
Sundries								10	0		3	0		1	6
Losses					12	0		16	6		10	0		5	0
Boar								15	0						
Weaner				2	0	0				2	0	0	2	0	0
Depreciation	7	10	0				2	6	8						
	£27	2	0	£11	6	0	£28	18	2	£8	0	0	£5	0	0

Wyllie costing a number of pig farms between the year 1932 and 1935 found that of the total cost, food accounted for 78 per cent, labour for 12·4 per cent and sundries for 9·4 per cent, but it should be noted that depreciation and losses were charged to a separate account. The relationship of labour to food (12·4 to 78) is the same as in the Wye costs in Table XX. It is interesting to note that Wyllie's cost per cwt. of purchased food was only 7/1d. in the years 1932–35 as compared with Fishwick's war-time figure of 15/– per cwt.

Before the war it was customary to speak of a weaner pig as costing £1, based on the sow costing £16 per year and rearing 16 pigs—nice easy figures to remember!

Equipment and its Use.

Suitable Device.

Weighing Apparatus. The necessity for weighing pigs so as to record the performance of sows, the progress of litters and the subsequent progress of the feeding pig has been emphasized several times in this book. Perhaps the most vital weight of all is that of a bacon pig which with pre-war grading had to be marketed within narrow weight limits but the litter weights are also very important. The price of the weighing apparatus is soon regained. The most suitable device for weighing litters is undoubted the spring balance with a canvas sling and two stout leather handles. The sling is put under the belly of the pig and the two handles are hung on the hook of the spring balance. The spring balance can either be suspended from a light tripod or can be hung from a suitably placed hook hanging from the roof or door of the farrowing house. The sow should be let out for exercise whilst the weighing is in progress, in case she gets upset by the squeals. Weighing should be carried out weekly from 3 weeks old until weaning. An alternative method of weighing litters is by putting the pigs one at a time into a wooden box standing on the platform of a sack weighing machine. Both these methods can be continued up to the weight of about 50 lb. after which the pigs become so strong that a major struggle ensues at each weighing and some form of weighbridge, into which the pig walks, is desirable.

The layout of the weighbridge should be carefully planned so that the pigs which are to be weighed can be driven into a gradually narrowing space. At the end of the narrow space is a small collecting pen in which the pigs are enclosed. The weighbridge should open at both ends so that a pig being driven from the collecting pen thinks he can walk straight through the weighbridge. As he gets on to the weighbridge both doors are shut. All surrounding hurdles or fences must be high enough to prevent a pig jumping out and strong enough not to be pushed back or broken.

There are several makes of movable weighing

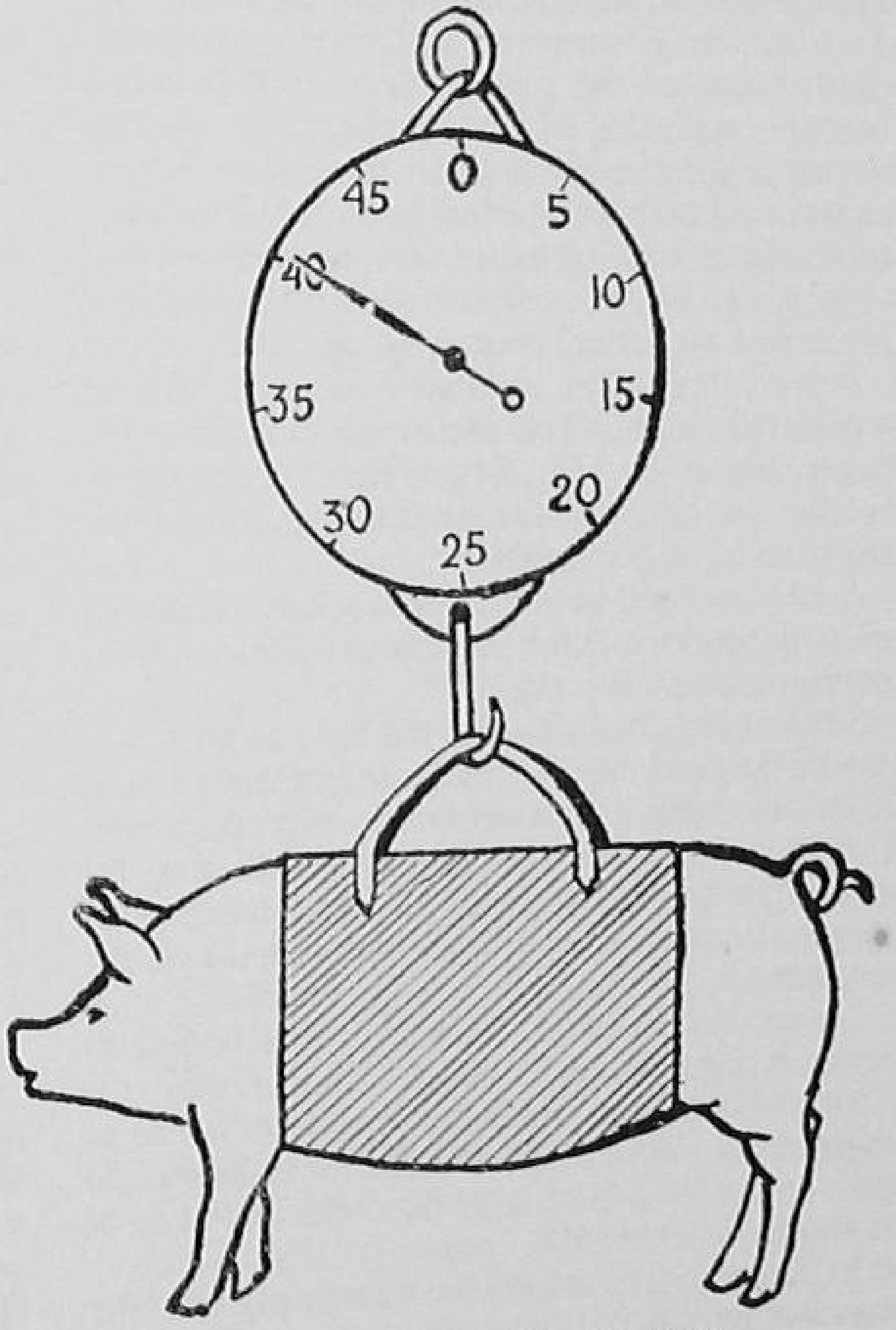
machines on the market, and of course, they are very much cheaper than a weighbridge. In each case the equipment consists of a crate, into which the pig has to be manhandled, and a spring balance. The crate can be raised clear of the ground and a direct reading obtained on the clockface. The chief advantages are that a rapid direct reading is obtained on the clockface and that the apparatus can be taken to the pigs, thus saving driving them to the weighbridge.

As each pig is weighed his number from his ear mark and his weight are recorded. This may be done on a card fastened up inside the pen and it should record breed, date of birth, date of weaning or purchase, rations and weights at different ages. These particulars should in due course be filed and kept for record purposes and from them interesting details regarding progress on different rations, etc., may emerge.

The Service Crate. This is a strong crate into which a sow or gilt is driven when on heat. She is fastened in and the crate is too narrow for her to turn round. When the boar starts to serve her his weight is supported by rests for his forelegs on either side of the sow. This enables a heavy boar to be used on small sows. The platform on which the boar stands is adjustable for height, so that a small boar can be assisted in serving a large sow by raising the platform.

Tethering. This method of fastening pigs involves the use of a strong leather harness which is used for tethering sows on grass. It is put on the sow as shown in the illustration (Fig. 16) and it has attached to it about 30′ of chain and a stout iron stake which is driven into the ground. The pig can thus graze a 30′ radius of ground. Her hut should be so placed that she can get well inside it, but not close enough to the stake to enable her to get round the hut and thus involve the chain. The sow should be harnessed at least 2 weeks before farrowing to enable her to get accustomed to the harness, which should be strapped tightly especially for the first few days. Food for her litter may be placed outside the circumference of the sow's circle grazing. The pre-war price of the harness, chain and stake was about 30/– and a number of makes were on the market. The tethers last for many years provided that the leather harness is kept well oiled.

Troughs. Feeding troughs may be either movable or fixed. Movable troughs may be of galvanized iron and either circular in shape if intended for sows or of the required length to suit a pen of pigs. Long shaped wooden troughs may be made at home, but they do not last as long as galvanized iron troughs because the pigs tend to chew the wooden sides. Movable troughs can easily be cleaned and the required number can be placed in any one pen to accommodate the number of pigs in the pen. Fixed troughs require more thought because once they have been built into a permanent pig pen they cannot be altered easily. Semi-circular glazed fire-clay set in concrete makes a satisfactory trough and one which is easily cleaned. In a permanent building it is desirable to be able to feed the pigs from outside the pen. There are two methods: (1) A top-hung shutter arranged over the trough so that the shutter can either be fastened inwards, shutting off the trough from the sty, or fastened outwards to give the pigs full use of the trough



METHOD OF WEIGHING YOUNG PIGS
FIG. 21

space. Bolts on the shutter will secure it in either position, enabling the food to be put into the trough or the trough to be cleaned without interference from the pigs. (2) A partition fixed over the trough nearer to the feeding passage than the sty; this enables feeding to be carried out without interference from the pigs, but is not so satisfactory for cleaning out the troughs.

Loading Ramp. Each pig unit should be provided with a loading ramp which may be built up of railway sleepers or other suitable material enabling pigs to be driven up the ramp to the height of the back of the lorry into which they are to be loaded.

Electric Fence. This consists of one or two strands of wire, through which an electric current is running. The current is generated by a 6 volt battery; the wires are supported on strong posts by insulators. Once animals have experienced a shock from it they do not normally touch the fence again. One wire is usually enough for horses and cattle, but pigs require two; many hundreds of yards of fencing can be operated by one battery. The battery should be under cover and in a place where it is easily inspected. Respect for the fence may be taught by enclosing the pigs in a small pen electrically fenced and then encouraging them to touch the wire by placing food just outside the wire. Properly erected this type of fence will give satisfactory results with considerable saving in labour and materials.

LITERATURE OF GOOD PIG-KEEPING

The farmer or student interested in the subject of this book will often find articles of interest in agricultural periodicals. The writer has referred to the work of many contributors to the *Farmer and Stockbreeder* and the *Farmers' Weekly;* these articles have been card indexed by the writer for some years and he would like to acknowledge here the help obtained from them. There are also many books and scientific papers available for study and the following list includes some referred to in this book; some are given as a guide to further study:—

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    - 1941. Home curing of bacon and hams. Leaflet No. 173.
    - 1943. Home curing of bacon and hams. Bulletin No. 127.
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Pig Breeders' Societies.

If any information is required about the various breeds of pig, the breed societies, whose addresses are given below will supply the necessary information. In addition to the breed societies most counties have Pig Recording Societies, which record the number and progress in litters belonging to their members.

Breed	Society	Address
Large White, Middle White, Berkshire, Wessex, Tamworth	National Pig Breeders' Association	Victoria House, Southampton Row, London, W.C.1.
Essex	Essex Pig Society	2nd Floor, 87 High Street, Chelmsford.
Cumberland	Cumberland Pig Breeders' Assoc.	38 Lowther Street, Carlisle.
Gloucester Old Spot	G.O.S. Pig Breeders' Society	Central Chambers, 8/16 Park Street, Bristol, 1.
Large Black	Large Black Pig Society	90 Cheddon Fitzpaine, Taunton, Somerset.
Large White Ulster	Large White Ulster Pig Society	Balmoral, Belfast.
Welsh	Welsh National Pig Society	Ruabon, Nr. Wrexham.
Lincoln Curly Coat, Lop-Eared	National Lop-Eared Pig Society	B. J. Roche, 12 Hanover Square, London, W.1.

Table XXI.

PROGRESS AND MEAL CONSUMPTION OF PIGS AT VARIOUS AGES

Age (Weeks)	lb. Weight for breeding	lb. Food for breeding	lb. Weight as pork	lb. Food as pork	lb. Weight as bacon	lb. Food as bacon	Water	Remarks
0	2½	Sow	2½	Sow	2½	Sow	qrts.	—
2	9½	Sow	9½	Sow	9½	Sow	—	—
4	16	Sow	16	Sow	16	Sow	—	Castrated
6	25	½	25	½	25	½	—	—
8	35	1½	35	1½	35	1½	—	—
9	38	1¾	38	1¾	38	1¾	—	—
10	42	2	42	2	42	2	—	—
11	46	2¼	46	2¼	46	2¼	—	—
12	50	2½	50	2½	50	2½	2	—
13	57	2¾	57	2¾	57	2¾	—	—
14	64	3	64	3	64	3	—	
15	73	3¼	73	3¼	73	3¼	—	
16	81	3½	81	3½	81	3½	3	
17	90	3¾	90	3¾	90	3¾	—	
18	98	3¾	100	4	100	4	—	
19	104	4	107	4¼	107	4¼	—	
20	110	4	116	4½	116	4½	3½	
21	116	4¼	125	4¾	125	4¾	—	May be killed as pork
22	122	4½	134	5	134	5	—	
23	129	4¾	143	5¼	143	5¼	—	
24	136	5	153	5½	153	5½	4	
25	143	5¼	163	5¾	163	5¾	—	
26	150	5½	173	6	172	6	4¼	
27	158	5½	181	6	181	6	4¼	
28	166	5¾	190	6	190	6	4¼	
29	175	6	—	—	200	6	4¼	Bacon above this weight.
30	184	6	—	—	210	6	4¼	
35	224	6	—	—	255	6½		Breeding gilts mated.
In-pig	—	3–6						
Suckling	—	8–14						
Boars	—	3–7						

Table XXII.

Quick Reference Table for Calculating the Approximate Dates on which a Pig will reach Bacon Weight and Intermediate Weights.

Pigs Born	Weaned	90 lb. L.W.	110 lb. L.W.	130 lb. L.W.	150 lb. L.W.	170 lb. L.W.	190 lb. L.W.	Bacon 210 lb. L.W.
1 Jan.	1 Mar.	1 May	20 May	3 June	17 June	1 July	15 July	1 Aug.
1 Feb.	1 Apr.	1 June	20 June	3 July	17 July	1 Aug.	15 Aug.	1 Sept.
1 Mar.	1 May	1 July	20 July	3 Aug.	17 Aug.	1 Sept.	15 Sept.	1 Oct.
1 Apr.	1 June	1 Aug.	20 Aug.	3 Sept.	17 Sept.	1 Oct.	15 Oct.	1 Nov.
1 May	1 July	1 Sept.	20 Sept.	3 Oct.	17 Oct.	1 Nov.	15 Nov.	1 Dec.
1 June	1 Aug.	1 Oct.	20 Oct.	3 Nov.	17 Nov.	1 Dec.	15 Dec.	1 Jan.
1 July	1 Sept.	1 Nov.	20 Nov.	3 Dec.	17 Dec.	1 Jan.	15 Jan.	1 Feb.
1 Aug.	1 Oct.	1 Dec.	20 Dec.	3 Jan.	17 Jan.	1 Feb.	15 Feb.	1 Mar.
1 Sept.	1 Nov.	1 Jan.	20 Jan.	3 Feb.	17 Feb.	1 Mar.	15 Mar.	1 Apr.
1 Oct.	1 Dec.	1 Feb.	20 Feb.	3 Mar.	17 Mar.	1 Apr.	15 Apr.	1 May
1 Nov.	1 Jan.	1 Mar.	20 Mar.	3 Apr.	17 Apr.	1 May	15 May	1 June
1 Dec.	1 Feb.	1 Apr.	20 Apr.	3 May	17 May	1 June	15 June	1 July

VETERINARY INFORMATION.

Oestrum:	Duration 2–4 days. Occurrence 3–10 days after weaning (sometimes whilst suckling). Recurrence 20–21 days.
Pulse:	70–80 per minute.
Respirations:	20–30 per minute.
Normal Temp.	102° F.
Notifiable Diseases:	Foot and Mouth disease, Swine Fever.

Ready Reckoner for Price of Feeding Stuffs.

Per ton £ s. d.	Per cwt. £ s. d.	Per stone s. d.	Per lb. d.
11 8	7	⅞	1/16
1 3 4	1 2	1¾	⅛
2 6 8	2 4	3½	¼
4 12 4	4 8	7	½
7 0 0	7 0	1 0½	¾
9 6 8	9 4	1 2	1
11 13 4	11 8	1 5½	1¼
14 0 0	14 0	1 9	1½
16 6 8	16 4	2 0½	1¾
18 13 4	18 8	2 4	2
21 0 0	1 1 0	2 7½	2¼

Table of equivalent values of dressed carcase per score (20 lb. D.W.); per cwt. (112 lb. D.W.); per Butcher's stone (8lb. D.W.) and per lb. D.W.

Per Score £ s. d.	Per cwt. £ s. d.	Per stone (8 lb.) s. d.	Per lb. s. d.
5 0	1 8 0	2 0	3
5 6	1 10 10	2 2¼	3¼
6 0	1 13 7	2 4¾	3½
6 6	1 16 5	2 7¼	3¾
7 0	1 19 3	2 9½	4¼
7 6	2 2 0	3 0	4½
8 0	2 4 9	3 2¼	4¾
8 6	2 7 7	3 4¾	5
9 0	2 10 5	3 7¼	5¼
9 6	2 13 2	3 9½	5¾
10 0	2 16 0	4 0	6
10 6	2 18 10	4 2¼	6¼
11 0	3 1 8	4 4¾	6½
11 6	3 4 5	4 7¼	6¾
12 0	3 7 2	4 9½	7¼
12 6	3 10 0	5 0	7½
13 0	3 12 10	5 2¼	7¾
13 6	3 15 7	5 4¾	8
14 0	3 18 5	5 7¼	8¼
14 6	4 1 2	5 9½	8¾
15 0	4 4 0	6 0	9
15 6	4 6 9	6 2¼	9¼
16 0	4 9 7	6 4¾	9½
16 6	4 12 5	6 7¼	9¾
17 0	4 15 2	6 9½	10¼
17 6	4 18 0	7 0	10½
18 0	5 0 10	7 2¼	10¾
18 6	5 3 7	7 4¾	11
19 0	5 6 5	7 7¼	11¼
19 6	5 9 3	7 9½	11¾
1 0 0	5 12 0	8 0	1 0

Live Weight and Carcase Weight.

Commercial Conditions* Live Weight lb.	Carcase Weight lb.	Carcase Percentage %	Show Conditions† Carcase Weight lb.	Carcase Percentage %
80·0	48·0	60·0	58·5	73·2
90·0	55·0	61·1	67·1	74·6
100·0	63·0	63·0	75·7	75·7
110·0	71·0	64·5	84 3	76·6
120·0	79·0	65·8	92·9	77·4
130·0	87·0	66·9	101·5	78·1
140·0	95·0	67·8	110·1	78·6
150·0	103·0	68·6	118·6	79·1
160·0	111·0	69·4	127·2	79·5
170·0	119·0	70·0	135·8	79·9
180·0	127·0	70·6	144·4	80·2
190·0	135·0	71·1	153·0	80·5
200·0	143·0	71·6	161·6	80·8
210·0	151·0	71·9	170·2	81·0
220·0	159·0	72·3	178·8	81·3
230·0	167·0	72·6	187·4	81·5
240·0	176·0	73·3	195·9	81·6
250·0	185·0	74·0	204·5	81·8
260·0	194·0	74·6	213·1	82·0

Note:—There are considerable possibilities for variation in the percentage of carcase weight to live weight. The most important factor which influences this percentage is the contents of the stomach, hence pigs which have been starved for a long period, as under Smithfield conditions, will return a much higher carcase percentage than pigs recently fed and watered.

The figures given above under commercial conditions may be taken as reasonably representative of normal farm conditions, *i.e.* pigs weighed within a few hours of feeding. Where pigs are weighed after an interval of about twelve hours from their last feed, the live weights shown in this part of the table would be approximately 4 per cent less, *i.e.* a pig weighing 192 lb. fasted weight could be expected to yield a carcase weight of 143 lb. or 74·4 per cent. It is advisable to allow the maximum live weights in order to be sure that the carcase is not underweight for bacon.

Composition of Pig Foods.

The composition figures required in calculating pig rations is given in this table. Only those foods mentioned in this book or which are in

* Adapted from Reports on East Anglian Pig Recording Scheme.
† Smithfield Show, all breeds 1914–33 from *Pig Breeders' Annual*, 1934–35.

common use are included in the table; it is possible to look up any other feeding stuff in the appropriate books.

	Per lb.				
	Dry Matter	Protein Equiv-alent	Carbo-hydrate Equiv-alent	Nutri-tive Ratio	Starch Equiv-alent per lb.
ROOTS	lb.	lb.	lb.		lb.
Mangolds	·132	·005	·09	1 : 18	·062
Potatoes	·238	·009	18	1 : 20	·185
Sugar Beet	·234	·006	·20	1 : 35·8	·150
GREEN FOODS					
Cabbage	·110	·009	·07	1 : 7·8	·066
Kale: Marrow Stem	·140	·014	·08	1 : 6·2	·091
Kale: Thousand Head	·158	·013	·09	1 : 6·9	·103
Lucerne	·240	·026	·10	1 : 3·9	·103
Pasture Grass	·200	·021	·11	1 : 5·2	·112
Sugar Beet Tops & Leaves	·195	·013	·09	1 : 6·9	·091
GRAIN & SEEDS					
Barley	·851	·073	·66	1 : 9	·714
Beans	·857	·197	·51	1 : 2·6	·658
Maize	·870	·077	·71	1 : 9·2	·776
Oats	·867	·076	·57	1 : 7·5	·595
Peas	·860	·181	·55	1 : 3·0	·690
Wheat	·866	·096	·67	1 : 7	·716
CAKES & MEALS					
Dried Blood	·860	·681	·02	1 : ·03	·629
Ext. Groundnut Meal	·924	·288	·26	1 : ·9	·444
Ext. Palm Kernel Meal	·900	·166	·56	1 : 3·4	·713
Ext. Soya Bean Meal	·887	·383	·32	1 : ·84	·640
BY-PRODUCTS					
Dried Grains	·897	·126	·48	1 : 3·8	·483
Flaked Maize	·890	·092	·76	1 : 8·3	·840
Maize Germ Meal	·892	·103	·76	1 : 7·4	·843
Maize Gluten Feed	·896	·192	·58	1 : 3	·756
Meat and Bone Meal	·903	·342	·33	1 : ·97	·678
Rice Meal	·911	·071	·67	1 : 9·5	·723
Fish Meal White	·870	·530	·09	1 : ·17	·589
Sep. Milk Powder	·898	·315	·50	1 : 1·6	
Sugar Beet		·052	·70	1 : 13·5	·606
Pulp, Dry	·900	·109	·56	1 : 5·1	·565
Weatings	·860				
Superfine	·867	·121	·60	1 : 5	·690
Wholemeat Meal	·920	·550	·25	1 : ·45	
Bran	·870	·099	·46	1 : 4·6	·426
Dried Yeast	·957	·408	·30	1 : ·73	·672

A NOTE ON COUNTY PIG RECORDING SOCIETIES.

The objects of these Societies are as follows:—

1. To improve the standard of pigs.
2. To record the productivity of sows and boars by litter recording and weighing.
3. To collect information on feeding and management.
4. To note the sows and boars which reach the required standard (number of births, litter weight at weaning, milking capacity as shown by 6 week-old weight, percentage of pigs reared to weaning age).

The value to the herd owner of such information is quite obvious. It may be argued that the owner would obtain the information for himself without the society, but his own unofficial figures would not be so convincing, when he sells his surplus breeding gilts, as the official society records. The healthy competition amongst members of the society is another advantage to be gained from membership.

A NOTE ON PIG CLUBS.

THE Small Pig Keepers' Council has done very good work in fostering the formation of pig clubs during the war. In 1944 there were 1,705 pig clubs in which the pigs were privately owned and 1,940 clubs in which the pigs were owned on a co-operative basis. The total number of pigs involved was 133,289 and membership of the clubs has included police, N.F.S., factory workers, farm workers, etc. The formation of such clubs has enabled a lot of swill to be collected in small quantities; this would not have been worth collecting where the time spent in its collection had to be paid for by an employer. A list of the pamphlets published by the Council will be found under "Literature of Good Pig-Keeping" p. 685.

GLOSSARY

Aitch bone, the corresponding bone in the pig to the hip bone in a human being.

Anaemia, a condition in which the blood has a low haemoglobin content; treated by remedies containing iron compounds.

Bacon, the cured flesh from a pig carcase. It is usual to cure pigs of over 140 lb. dead weight, but parts of smaller carcases may be cured.

Back fat, the fat over the back and loin.

Baled, straw tightly compressed by machinery into rectangular bales, bound either with string or wire, the latter being the more suitable for pig houses.

Blade bone, the shoulder blade or scapula.

Bloom, the sleek, shiny, healthy appearance of the coat of a healthy animal.

Boar, an uncastrated male pig.

Brawn, made by boiling pigs' heads (ears, cheeks, etc.), trotters and tail.

Brewer's grains, the residue of the barley grain after the extraction of the malt for making beer. May be sold as wet grains or, after drying, as dried grains.

Capital, in this book means the sum of money invested in a pig farm or in the pig branch of a mixed farm.

Carcass or carcase, the dressed body of a pig after removing the internal organs, hair, etc.

Casings, parts of the small intestine of the pig used for sausage skins.

Castrated, term used of a male from which the testicles have been removed.

Castration, the operation of removing the testicles.

Creep, a structure (of which there are many forms) which contains openings that are too small to allow the escape of a sow but which are large enough for young pigs to emerge.

Cross-bred, the progeny of the mating of a boar and a sow of two different breeds or of the mating of a boar and a sow not of a pure breed.

Cutters, pigs whose dressed carcase will be 100–140 lb.

Dressed weight, dead weight or D.W. is the weight of the carcase as opposed to live weight.

Farrowing, the birth of the litter.

Fillet, alternatively known as tenderloin. Cut away from the underside of the loin bones after disembowelling has taken place.

Flare, fat lining the abdominal walls and running up round the kidneys. Also known as leaf or flick.

Fore-end, the forepart of the pig or carcase; includes everything in front of a line through the pig just behind the foreleg.

Gall bladder, a small bladder attached to the liver. It stores a digestive juice (bile) produced by the liver.

Gammon, ham or hind leg.

Gestation period, the interval between mating and birth.

Gilt, a female pig up to the time her first litter is weaned. After that the animal is known as a sow.

Hammer Mill, a rapidly revolving grinding mill which employs beaters instead of plates. Adjustable to grind any type of grain to the desired fineness.

Hams, the hind legs after curing; the term is sometimes used to refer to the hind legs of the living pig.

Heat, a female is "on heat" during the period of oestrum.

Landrace, a Danish breed of pig.

Litter, a term used to describe collectively the pigs produced at one birth.

Loin, the part of the spinal column and adjacent parts just in front of the tail region.

Meal, a food that has been ground until it consists entirely of fine particles.

Midland cure, a method of curing a side of bacon in which the hams and fore-end are removed before curing.

N.P.B.A., National Pig Breeders' Association responsible for the Large White, Middle White, Wessex Saddleback, Berkshire and Tamworth breeds.

Oesophagus, the gullet.

Oestrum, see also Heat. The period during which the female sheds eggs and during which she can be mated.

Ovum (plural *ova*), the egg from which the young develops after fertilization. One sperm must unite with one ovum to fertilize it and prepare it for development into a young pig.

Placenta, the afterbirth, placental membranes or cleansing.

Pluck, the lungs, heart, liver, trachea (windpipe) and oesophagus (gullet). These are all removed together from the carcase after disembowelling.

Pork, the fresh, frozen or salted flesh from a pig carcase.

Porkers, term used to describe pigs whose dressed weight will be 60–80 lb.

Puberty, the sexual maturity of an animal. After reaching the age of puberty the animal is capable of breeding.

Rectum, the last part of the bowel.

Runt, the poor pig in a litter. It is not only small, but unhealthy and generally unthrifty.

Score, 20 lb. of pig. It may be expressed in scores live weight or in scores dressed weight.

Seedycut, a black discoloration of the milk ducts in the belly, causing a blemished carcase, more common in black breeds.

Service, alterative word for mating.

Silage, alternatively called ensilage. A conserve of green foodstuffs, potatoes, etc., prepared by storing in a silo.

Silo, a pit or building, often in the form of a tower, for the preparation of silage.

Spare rib, lean meat attached to the ribs.

Spay, the removal of the ovaries from female pigs pigs to prevent breeding.

Spermatozoa, the male reproductive cells or sperms, which unite with the female eggs to produce young pigs.

Spleen, also called the milt. Its functions are (1) to form white blood corpuscles and in certain animals, red corpuscles, (2) to disintegrate some of the red corpuscles which have discharged their function and are worn out, (3) to take part in nitrogenous metabolism in the formation of uric acid.

Stone, either 8 or 14 lb. The weight of a live pig and of bacon is invariably measured in 14 lb. stones. Pork carcases may be weighed in either 8 or 14 lb. stones, but the 8 lb. stone is the more usual.

Stores, pigs which are not at the moment being fattened. They may be for breeding or for subsequent fattening.

Streak, lower part of the middle of a side of bacon; also known as the belly.

Sweetbread, a digestive gland, technically known as the pancreas.

Testicles, the male organs which produce the spermatozoa.

Tethering, fastening pigs in grass fields by means of a leather harness, chain and stake.

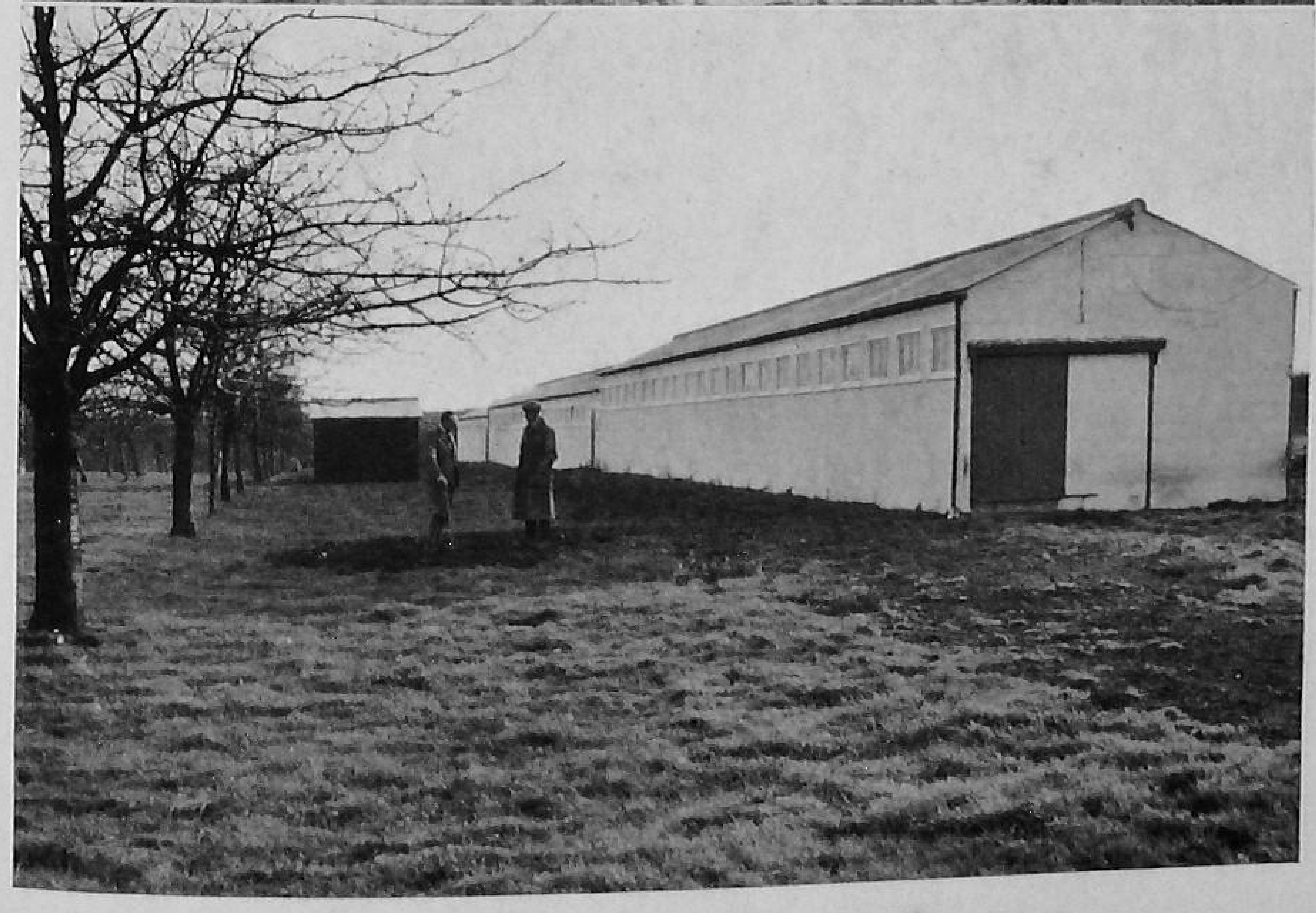
Trotters, pigs' feet. The flesh may be eaten as such or made into brawn.

Weaning, the separation of sow and litter so that the litter ceases to have the sow's milk.

Wiltshire cure or cut, a side of bacon which is cured in one piece, contrasted with the Midland cure.

Windpipe, the trachea or tube carrying air from the mouth to the lungs.

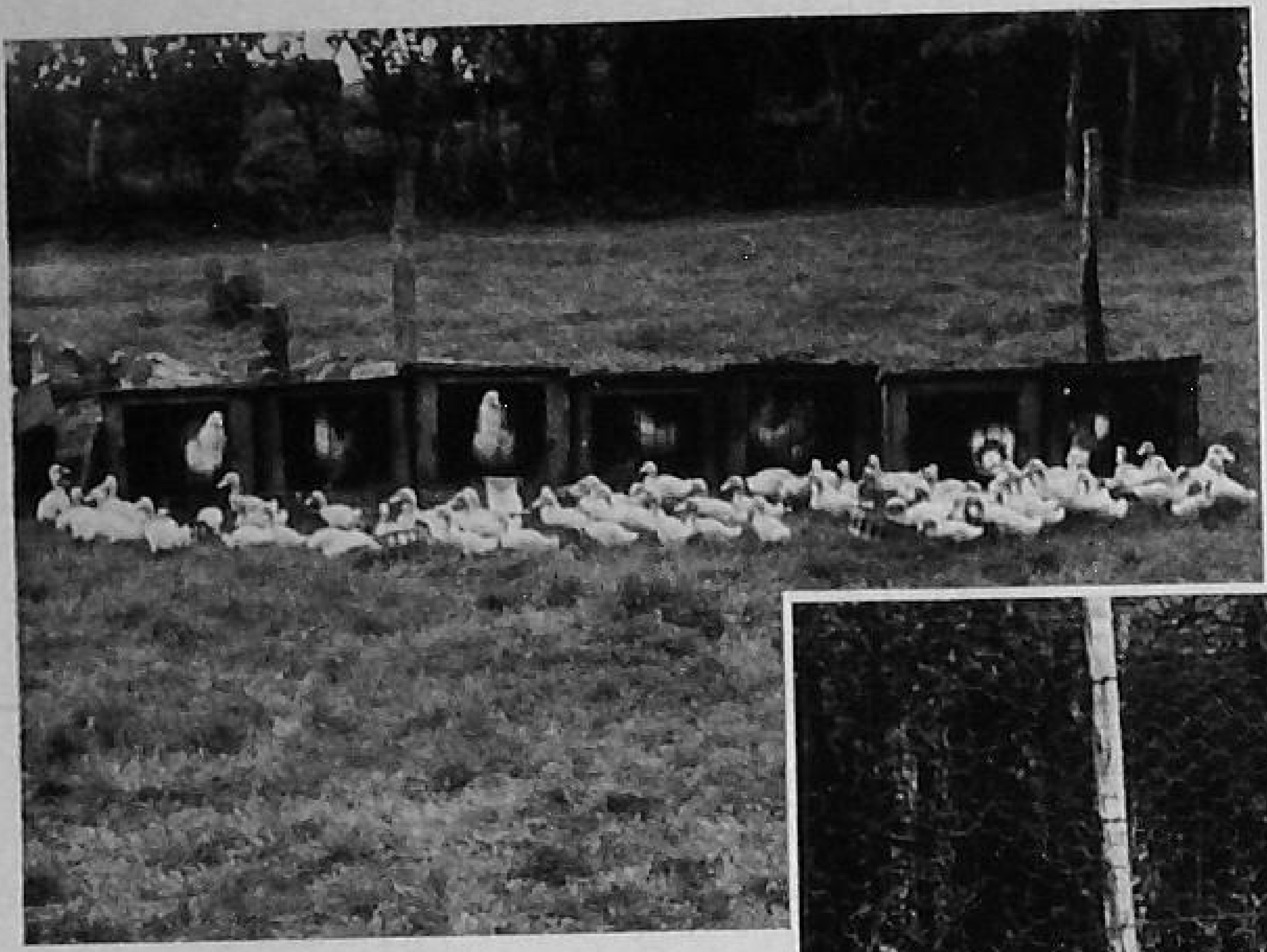
Withers, the point in the upper line of a pig where the shoulder blades end.



MODERN POULTRY FARMING

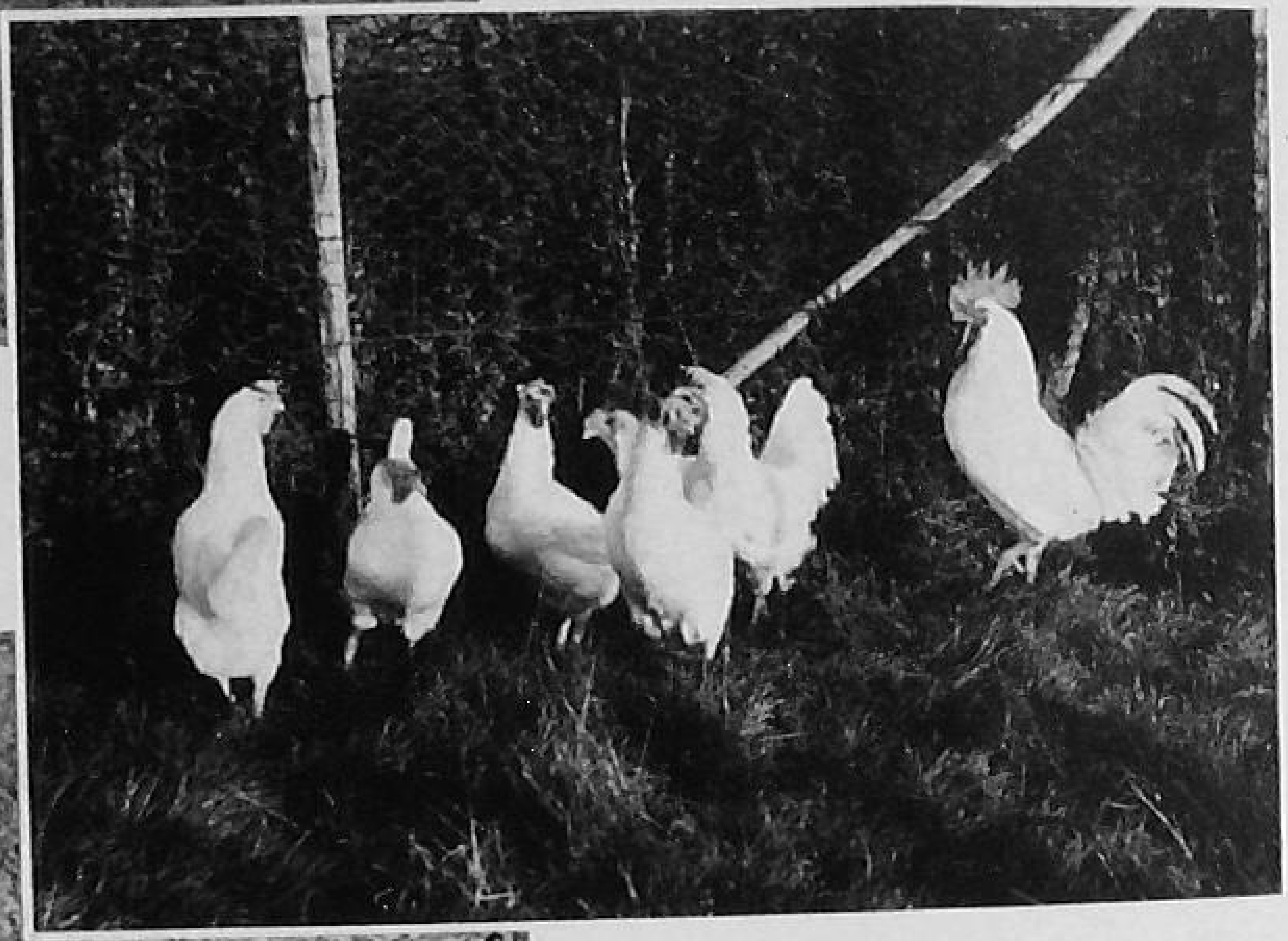
Above : BREEDING PENS — *Farmer & Stockbreeder Photograph Courtesy: Nackington Farms*

Below : UP-TO-DATE BROODER HOUSE — *Courtesy: Nackington Farms*



Left : DUCKLINGS RAISED BY HENS
Photo: Modern Poultry Keeping

Below : WHITE LEGHORNS
Photo: Farmer & Stockbreeder



Left : BLACK LEGHORNS
Photo: Farmer & Stockbreeder

Right : BROWN LEGHORNS
Photo: Farmer & Stockbreeder

BRITISH POULTRY

All pictures by courtesy of Nackington Farms

SECTION V

GOOD POULTRY KEEPING

by

C. E. FERMOR
Wye College (University of London)

Illustrated by

FLORENCE E. FERMOR

PRELIMINARY NOTE

THINKING of the Poultry Industry at the present time, and comparing it with the day when I set out in company with my sister to meet Mr. Hanson and learn from him the details of the new semi-intensive system of keeping poultry, it seems hardly possible that it was only some thirty-three years ago—not a long time in the life of an industry.

I remember the thrill with which we put up our new houses with the open fronts, their only protection from the weather being muslin shutters. The Wyandottes we kept at the time were fine birds, eggs were in plentiful supply, and the birds never knew a cold, despite the fact that their houses were at times surrounded by deep snow.

We were, of course, enthusiasts for the new system, and I think spent a lot of time with the birds, feeding on the late Mr. G. A. Palmer's well-known but complicated mashes.

How we waited for the little pink covered periodical " Eggs " to arrive, and drank in week by week Mr. Tom Newman's advice, which to most of us, seemed quite revolutionary!

A lot of water has flowed under the bridges since those days, but it is well to pause at times to pay a tribute, albeit a silent one, to the Pioneers of what is now a very large industry in the country.

Most of what appears in the following pages has been said many times before, and I make no claim to originality, though perhaps its presentation is seen in a different dress.

It is made up in part from the notes which I have used for lecturing to students. At the same time the experimental work in which I have been engaged for some considerable time has afforded an opportunity of seeing poultry problems from an angle not always available to the general farmer; here again my experience has coloured what I have said in this book.

If I have unwittingly employed the ideas of other writers on poultry subjects, known and unknown to me, I offer here my apologies and acknowledgments. I owe much, of course, to others who have taught and written in the past.

To Mr. E. T. Halnan, M.A., Lecturer in Agriculture, in the University of Cambridge, with whom I have worked in happy collaboration for many years, I am indebted for reading the drafts for this book, and for allowing me to borrow information from many of his published works.

To my sister, Miss F. E. Fermor, I am indebted for the black and white illustrations.

If these pages should prove to be of some use to the newcomer to the Industry, or to any already engaged in it, the time spent in writing the book will have been well occupied.

C. E. FERMOR.

WYE COLLEGE
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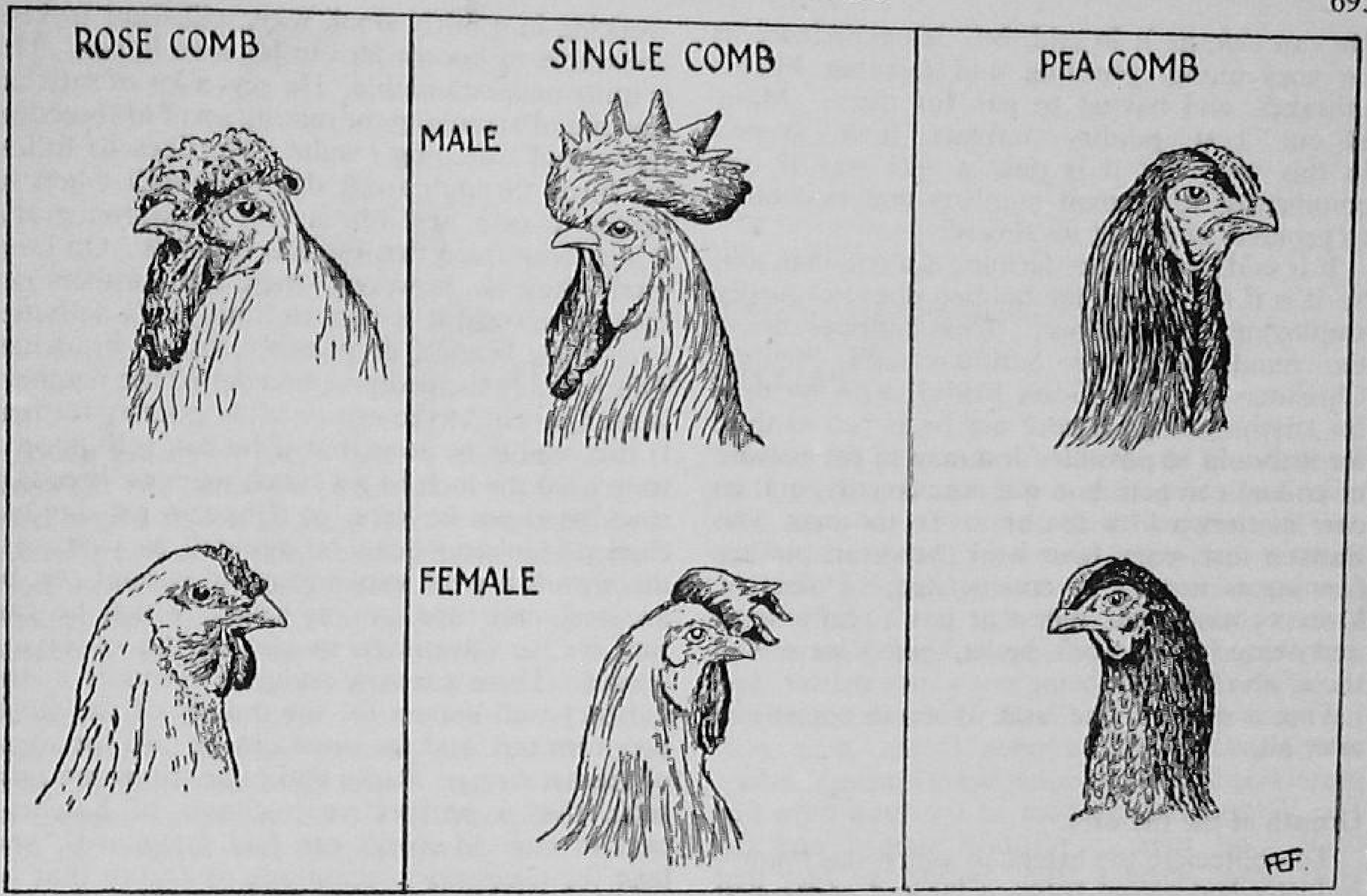
WYE, KENT.



INTRODUCTION

Tracing the growth of the Poultry Industry from earlier days to the present time, and dealing with different branches of Poultry Farming now practised.

The Past.

POULTRY farming as we know it to-day is a very different thing from what it was before the Great War of 1914–1918. To the older generation, it does not seem so long ago that such home produced eggs as were marketed came from smallholders, cottagers, and the general farmer. No attempt was made to treat the matter as a business. Fowls were either confined to a small run, which in a very short time took on a most unhealthy appearance, or they were allowed to range. In the latter case the farmyard was their home, where they had to fend for themselves to a great extent, their food, in addition to what they found, being a few handfuls of corn. The care of the fowls was usually in the hands of the lady of the house, and it was an accepted rule that the money, made by the sale of eggs and poultry, belonged to her by right.

This style of poultry farming was all very well as far as it went, there was no rent or labour to pay, and perhaps the corn was to be had for the asking. It must be said that an excellent egg was put on the breakfast table.

On these haphazard methods, poultry could not be made to pay, if overhead charges, such as rent and wages, had to be met, since the output of eggs per bird per annum stood at such a low level. As a matter of fact poultry keeping was just tolerated by the farmer. His attitude, had he been asked what he thought of it as a business, would probably have been one of amused contempt. It is astonishing, after the great strides the industry has made in recent years, how this feeling is still found in some quarters. It is possible that the great number of failures on poultry holdings which occurred amongst ex-service men and others new to the work, who came into the industry just after the 1914–18 war, accounts in great measure for this indifference. Poultry farming at that time entered into a prosperous period. The industry advanced by leaps and bounds, perhaps too quickly for its good, for new ideas were often propounded and put into practice before being thoroughly tested. Tribute, however, must be paid to the pioneers whose spade work made the poultry farm what it is now. Men like Hanson, who gave us the large semi-intensive house with its alternate runs, revolutionized the industry to a great extent. Nor should one forget the Research Workers who have helped to make the path of the Poultry Farmer less hard.

Poultry Farming is a Business.

Poultry farming is, of course, like any other business. It is absurd to enter into it without thorough knowledge and experience. Nor should it be a cause for wonderment if failures occur, where this most necessary precaution is not taken. It is true that if a man has the necessary capital and can afford the time, he may start in a very small way without a lot of previous knowledge.

He can can, as it is said, buy his experience as he goes along, profiting and learning by his mistakes, and having to pay for them. Many of our best poultry farmers have started in this way, but it is only a safe way if one commences with small numbers and is content to progress and built up slowly.

It is said that poultry farming is a one-man job. So it is if the size of the holding does not justify employing other labour. This conjures up in the mind, work on Saturday and Sunday, Christmas day and Good Friday, with no time for anything else. It need not be as bad as that, for it should be possible for a man to get his wife or children to help him out occasionally, and so ease matters a little for him. To the man who wants a forty-eight hour week, however, poultry farming is not to be commended. Unless he loves a country life, unless he has a real interest and liking for the work, he had better leave it to those who feel that being one's own master, and having a stake in the land, is worth something after all.

Growth of the Industry.

To appreciate the extent to which the Poultry Industry had grown between the end of the first and the opening of the second world war, it is only necessary to point out that according to the Ministry of Agriculture's returns for England and Wales for the period 1937–1938, the estimated value of output in respect of poultry and eggs, amounted to £22,600,000, whilst the value of the corn crops was £12,910,000.

In the expansion that has taken place, the different activities of the poultry farm have tended to grow into businesses themselves. So that whilst there are still the large egg farms, breeding has become a specialized business and we have pedigree breeding establishments, and hatcheries. The production of Table Poultry is no longer the side line of the egg farmer who must get rid of his surplus cockerels. There are properly run table poultry plants. Fattening or conditioning stations relieve the producer of this skilled work, if he so wishes. Packing stations market both eggs and poultry for a small fee. Indeed, at the present time, as a war measure, the marketing of eggs through a packing station is compulsory, and for those who are apt to look on anything that savours of compulsion or co-operation with disfavour, it is well to remember the old adage, " United we stand, divided we fall." The poultry farmer needs to take that axiom to heart as much as anyone.

Specialized Organizations.

It will readily be seen that with the establishment of these specialized organizations within the industry, the way of the general poultry farmer has been made easier. We shall, it is true, always have the genuine lover of poultry, who, working in a fairly small way, will want to keep the whole of his concern in his own hands. This is quite understandable. He gets a lot of satisfaction out of arranging the mating up of his breeding birds, and watching results. He likes to follow his birds through from day-old, until when he comes to trap nest his layers, he knows everything about them that there is to know. On large establishments, however, where the numbers run into thousands, it is best to limit one's activities to a single branch, or possibly to two branches. This is where the pedigree breeder or the hatchery is such a help to the egg or table poultry farmer. It can readily be seen that if he can rely upon a source from which to get hatching eggs, breeding stock need not be kept, or if he can get day-old chicks, incubation can be avoided as well. By this means a great expenditure of capital can be avoided, and time can be saved, which he can well use to advantage in his rearing or laying houses. There are now pedigree breeders in the industry well-known for the quality of the stock they turn out, and the same can be said for some of the hatcheries. Rules and regulations are now such, that a prospective puchaser of hatching eggs or day old chicks can find safeguards, and take the necessary precautions to ensure that he gets exactly what he is asking for. What branch would a newcomer to the industry wish to take up? Let us deal with each in brief, in order to help him to form an opinion.

The Newcomer.

He will quite obviously not wish to start in as a pedigree breeder, for this is a job which most certainly calls for years of experience, and painstaking work. It is the pedigree breeder who supplies the industry with hatching eggs, day-old chicks, growing pullets and mature stock. The ordinary poultry farmer goes to him for a change of blood, for a male bird to head his breeding pen which he hopes will provide him with pullets which will give him a higher egg yield, and for stock of an increased size for larger eggs. Now the pedigree breeder has to spend his time in constantly selecting or rejecting stock so as to mate up what he feels will give him what he requires. He is able, in selling eggs or stock, to give details not only of the dam's production over a year, but also the record of the sire's dam as well. All this makes for the heavy work of trap-nesting all through the year, with all that is entailed in the recording of the eggs, together with details as to broodiness and other characteristics of the bird. No, this is certainly not the work for the newcomer to the industry for some time to come.

The same thing can be said for the hatchery. The work of the hatchery is simply to provide day-old chicks to customers. These day-old chicks, usually hatched weekly by the thousands in large cabinet incubators, come from eggs the hatchery purchase from breeders well-known to

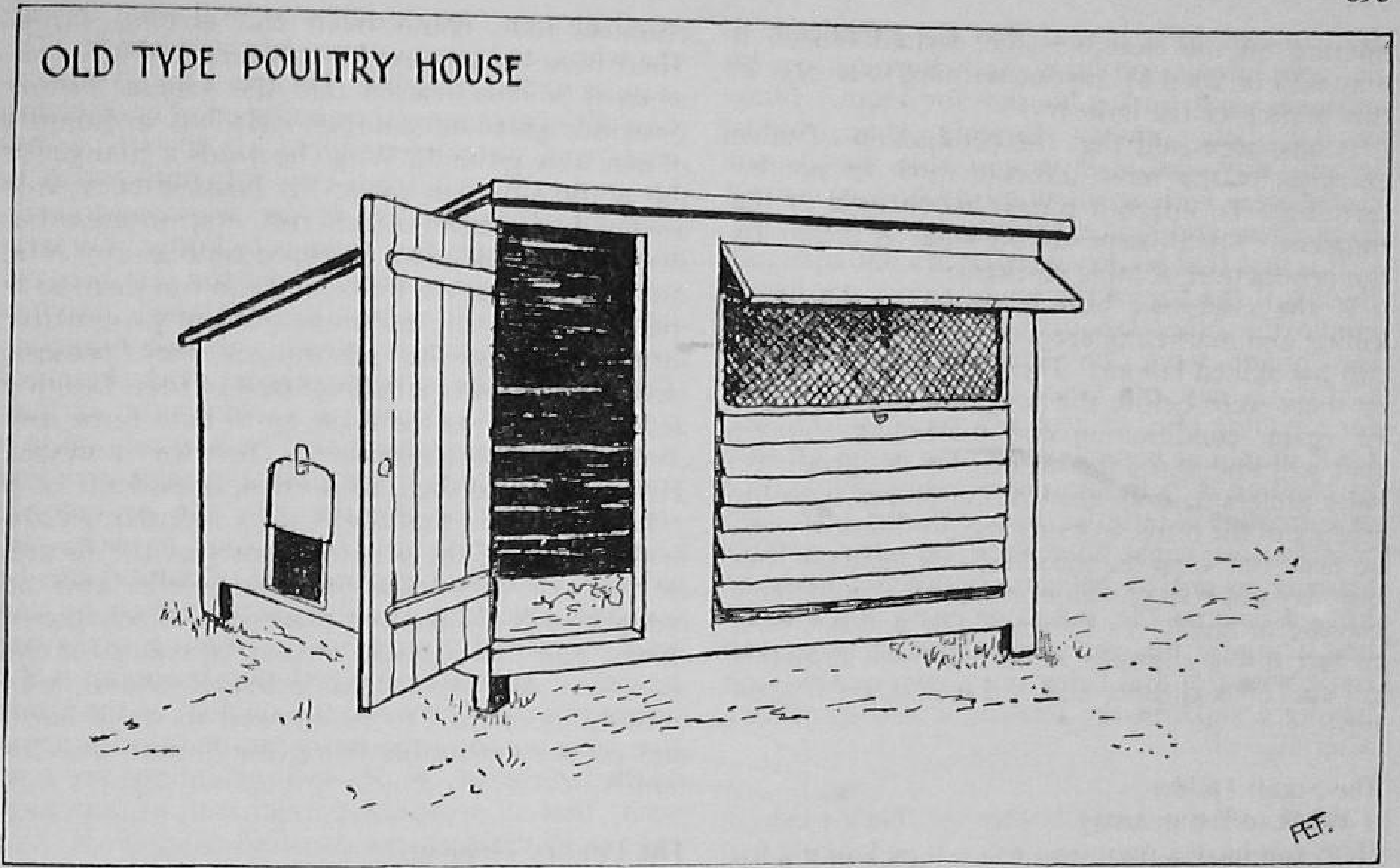


FIG. 1.—Usually associated now with Back Yard Poultry-keeping.

them for their reliability, and with whose stock they are acquainted. This work again is obviously the province of one who has long been engaged in the work of poultry farming and knows its many problems.

The Egg Farmer.

Egg production, to which most people turn when they are starting in poultry farming, does not consist simply in feeding the birds and collecting the eggs. Some idea must be known of the requirements in the way of food of the growing pullet, and the laying bird. Birds, if they are properly fed, will not be over-fed. One must know how to handle birds, to see when they are too fat or out of condition, and what steps to take to apply a remedy. The poultryman should be able to distinguish the layer that is paying its way from the non-doer, with a view to eliminating the latter. He should be ready with precautionary measures to keep down insect vermin, and be able to distinguish—and deal promptly with—the beginnings of an outbreak of disease. It is more than probable he will be buying in day-olds or young stock as replacements to go into his laying houses each season, and he must be well versed in rearing these young birds. So it will be seen, he has plenty to do, without necessarily taking on breeding or even incubation. One point in which research has helped the egg farmer, is that he is now able to buy with certainty pullet chicks. That is to say, research has given him the sex-linked pullet. If he objects to cross-bred birds, science has again stepped in to help him with the sexed day-old. It is not so long ago that the purchaser of day-old pure bred chicks had of necessity to have both pullets and cockerels. He did not really want the cockerels, but with the heavy breeds at least, he had to wait for nearly three months before he could distinguish them properly, and get rid of the cockerels if he did not wish to fatten them himself. With only pullet chicks to deal with, his brooding and rearing equipment is halved, or alternately he can deal with larger numbers at one time, and so get through his rearing sooner than heretofore.

Table Poultry.

The activities of the table poultry plant will, as its name implies, be confined to the production of poultry for the table. This is an all the year round job of bringing birds along for consumption, at weekly or fortnightly intervals, practically all through the twelve months. Its advantages over egg production are that one's capital is turned over more frequently, and that the initial outlay in buildings and stock need not be so great. The work consists wholly in rearing and getting ready for the table, birds that will carry the maximum amount of flesh in the shortest possible time. If it is desired to put on the market birds that have been conditioned by cramming, then that is the work of the skilled man and should not be attempted by the novice. If on the other hand a good chicken, fattened with a

mixture on the trough is the desired object, it may well be tried by anyone wishing to engage in this branch of the industry.

It has been said that the production of table chickens is the most difficult work in poultry farming. To adapt a phrase much used at the moment, " It all depends on what is meant by the production of table chickens."

If the crammed bird is to be produced, if killing and marketing are to be done, then it does call for skilled labour. There are now, however, or there were before the war, and probably will be again, conditioning and marketing stations that will undertake this work. So the producer, if he prefers it, only need be concerned with the rearing of the birds. As with the producer of eggs, he need not keep his breeders, nor incubate, but buy day-old cockerel chickens from the pedigree breeder or hatchery. Obviously he will not want to buy pullet chickens as he will most probably get cockerels cheaper and will rear larger framed birds.

The Small-Holder.

What of the small-holder or back-yarder? Here you have a man who will not be looking for a living from poultry alone. The small-holder will keep his cow, perhaps grow some corn or roots, and run a pig or two, in addition to keeping fowls. The backyarder will be mainly concerned with providing his breakfast table, and possibly that of his neighbour, with fresh eggs. The stock of poultry in such cases will therefore not be large, and any replacements that may be required are likely to be purchased as pullets, partly or fully grown, or hatching eggs may be bought and set under broody hens. These broodies will not only bring out the chickens, but will also brood and rear them until they are old enough to fend for themselves.

The General Farm.

This short survey of the Poultry Industry would be incomplete without some reference to poultry keeping on the general farm. It may come with surprise to many readers to hear that some 75 per cent of the total eggs produced in this country now, come from the general farms. There need be no cause for wonderment, however, when it is remembered that the general farmer possesses great advantages. He has a quantity of available ground. When he needs a change for the poultry he can range his birds over a wide area and, if not too thickly run, even where other stock graze. He also, in peace time at any rate, can find corn for the birds, and can run them over the stubble in the autumn. Many progressive farmers, seeing the advantages they possess, have made poultry a definite part of their farming activities, running them on up-to-date lines, and employing labour especially for the purpose. That it has paid them to do this, is evident.

It is often said that the poultry industry will be in the hands of the general farmer of the future. Be that as it may. The pedigree breeder and the hatchery will always find places in the scheme of things, and there should always be room for the man who, desiring a stake in his homeland, asks nothing more than to be allowed to work hard, and get a comfortable living for himself and his family.

The Poultry Holding.

Nothing has yet been said about the poultry holding itself. A satisfactory place always wants finding. It need not necessarily be a place already run as a poultry farm. In some cases it is better otherwise, especially if the area of the land is limited and has been heavily stocked. Sometimes it is possible to rent a small grass farm where poultry have not been run at all, instead of having to purchase. The advantage of such a place is that there are often available buildings which, with little conversion, can be made to serve as Incubator House, Food Store, Brooder House and the like. This is naturally a saving in capital. The land should not be heavy clay; a medium loam is best. Distance from a town or rail is not so important nowadays, when transport is so easy, and those wishing to do business will come to the farm. Every effort should be made to obtain a place where water is laid on. To be without this very necessary convenience can be very troublesome.

SYSTEMS OF POULTRY KEEPING

Free range, semi-intensive and intensive systems. Their advantages and disadvantages.

Various Methods.

AFTER deciding what branch of poultry keeping to take up, it is necessary to have some idea of what system to use. There are various ways of keeping poultry. Some have been in use for a good many years, others are comparatively new, but all have by now had a good trial on commercial holdings. One cannot say that there is any *best* way, such a lot depends on the circumstances. It would not be reasonable to advise a general farmer with his many acres to keep his birds intensively, nor could a small-holder adopt the free range system.

No system should be condemned as a system, but rather condemnation should come from the use of any system, however good in itself, in circumstances which do not justify it.

The various methods now practised may be grouped as (i) extensive or free range, (ii) semi-intensive, and (iii) intensive. These three groups can be further divided. For instance, the intensive system may include large laying houses, or it may mean the use of the laying battery.

It will be well to discuss these three systems in detail.

Free Range.

Free range brings into the mind's eye the large fields of the general farmer. One visualizes a portable house taking up to 50 birds, used simply for roosting and laying purposes, the birds ranging at will on the grass, and in the Autumn over the stubble. Provided that no harm is likely to come to these free-range birds from vermin, this is a good and cheap way of doing things. The house can either be the colony house, or a newer type known as the slatted-floor house. The former has a wooden floor and is fitted with skids or wheels to facilitate easy moving. Because it is to be moved, it is better kept small, a workable size being, say ten feet by six feet, which, allowing for two square feet per bird, will give housing accommodation for thirty. The modern slatted-floor house will take more, requiring only one square foot per bird, and will probably cost less to purchase.

This system is simplicity itself. There is no danger of overcrowding, no danger of fouling the ground, and no expense necessary in the purchase of wire netting for runs. When the birds are on the stubble they will probably keep themselves for an appreciable time, and even on grass will pick up a lot in a day. The benefit to the birds themselves from unrestricted exercise is apparent.

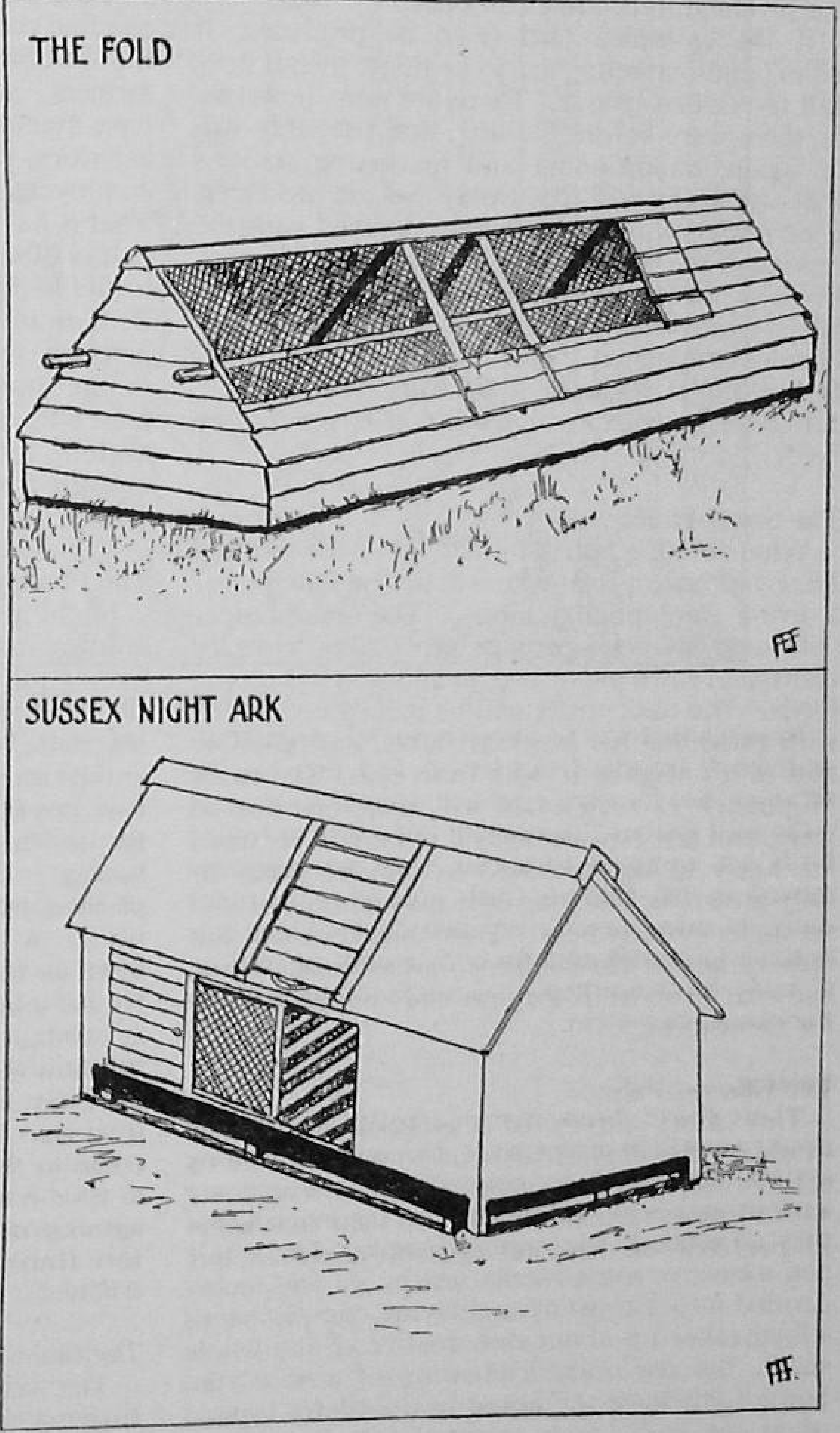


FIG. 2.—*Above.*—Popular type of housing for layers.
Below.—Useful for growing stock.

When large permanent houses for birds on extensive range are erected in fields to which cattle have access, it will be found necessary to erect a fence of hurdles, or something similar, around them. This will allow the birds to get through and range the field, and will at the same time keep the cattle away from the house.

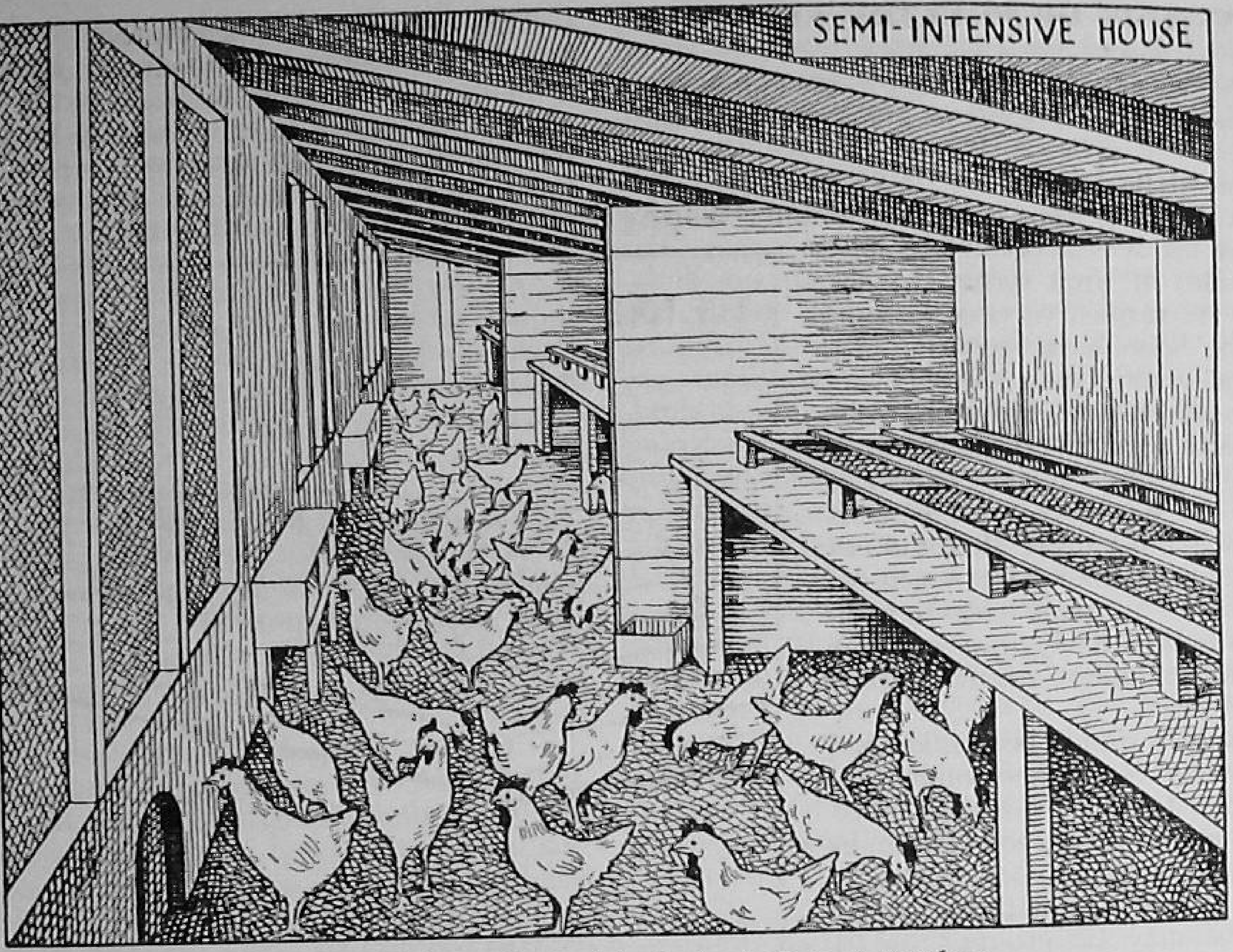


FIG. 3.—Birds can be kept in during inclement weather.

In some districts to allow birds to range at all will mean trouble from foxes, and this can be serious. So, farmers now use what is known as " the fold system " to obviate this. Whilst folded birds are confined to a run, they are regularly moved in the fold to fresh ground, sometimes daily, in other cases every two days. Since this needs a fair-sized area for satisfactory operation, if many birds are kept, it is included here under the extensive system.

Folding.

There have been many innovations in the poultry world in recent years, this one, the folding system, has much to commend it. There are various makes of folding pens on the market, but they all embody the same principle. The whole pen measures some twenty feet by six feet, being divided into a roosting-and-laying compartment, which takes up about one quarter of the whole space, the remainder consisting of a wire run. Some folds have the house in the centre instead of at the end. It is essential for purposes of moving, that the whole structure—whilst made strongly, and soundly built—should not be made of timber that is too heavy for handling. Some pens are so constructed as to be moved easily by one person. Whilst the roosting compartment will also contain the nests, the opposite end of the run will take the broody coop, water fountains and food hoppers. Most of these folds will hold from 25 to 30 laying birds. For housing, they are cheap, the price before the war being about £6 for the whole outfit.

Besides being a protection against foxes the fold has other advantages to commend it. After the birds have become used to their sleeping quarters, there is no letting out in the morning, or shutting up at night. The poultryman who has his birds accommodated in a distant field will appreciate this, especially during the days when we have Summer Time.

From a general farmer's point of view it is interesting to note that where birds have been properly folded, the grass greatly improves in quality. Especially is this the case with poor pastures where birds will scratch out all the old grass. Some 30 birds will, it is estimated, void about one ton of fresh manure per annum. From this it is possible to find to what extent any particular field has been manured.

The Semi-Intensive System.

The semi-intensive system is, as its name suggests, a compromise between the free range and the intensive system. It is in use on commercial holdings where the land available is limited. When this method of poultry farming was first introduced into this country some years ago, it was usual for the birds to be accommodated in houses which would take a good sized flock, and to each house were attached alternate runs. These runs were ploughed up when vacated and planted with arable crops. It was usual to keep the birds in one of the runs for about six months at a time. This idea has been

modified in recent years, the flocks being reduced in numbers and the runs sown down to grass. Whilst the semi-intensive system at its first introduction to this country allowed for as many as 300 to 400 birds to the acre, a lower figure is now favoured, and houses are preferred that hold 100 to 150 laying birds. The semi-intensive method has advantages and disadvantages. The man who takes a lively interest in his birds, derives great satisfaction from seeing them happy and comfortable in their quarters in the most inclement weather. Provided precautions are taken against overcrowding, these well-littered, well-lighted, houses can be safely used for keeping the birds intensively when the weather demands it. The disadvantage of permanent erections is the possibility of getting the ground around the houses into so stale a condition as to be a source of danger to the birds. Every care must be taken to avoid this, perhaps the best way being the occasional removal of the top spit of bare patches and replacing with fresh earth. A careful watch must be kept also in large houses for any appearance of disease. It will usually be found that the egg yield in the winter will be higher on this system than from birds kept on free range.

The Intensive System.

The intensive system is practised either where land is not available, or where the latter has been used to such an extent as to make its further use unwise. Under the intensive system, the birds never leave the house. As will be realized, it is a system that can be practised with special advantage on poultry farms situated near the towns where land for the other systems is too expensive to purchase, or not to be had at all. It is advisable to keep the birds in flocks of not more than 100 to 150. Whilst this will add to the cost of housing, it may be the cheaper way in the long run. Special care must be taken on this system. For example, overcrowding must be avoided at all costs, if feather plucking and cannibalism are to be avoided. Errors in feeding or management with this method of keeping birds may mean disaster.

Housing.

Housing, where birds are to be kept intensively and semi-intensively, is of extreme importance. When contemplating the erection of the houses, especially those of the large and permanent type, it is well to take trouble to ensure getting the best. Cheap houses can be both nasty and expensive in the long run. It should be particularly insisted that only seasoned wood should be used in construction. Very good second-hand houses can sometimes be picked up at sales at bargain prices. If these can be found fairly close at hand so as to obviate high transport charges, they are worth considering. The purchase of second-hand houses is frequently condemned. Providing the farm from which they come is known to be free from disease, and the houses are bolted, so that all the sections can be thoroughly cleansed and disinfected before re-erection, they should prove a good investment. Ventilation in these houses must be carefully noted. If the house appears stuffy night or day, then the ventilation is at fault and should be remedied. On the other hand, ventilation must not be overdone. A draught will mean colds. Perhaps the best way of ventilating a house is from above the birds. About thirty-six cubic feet of air space per bird should be allowed for intensively kept birds. Each house should be so placed that the maximum amount of sun can get into the interior. Ultra-violet ray glass should be used in the windows, which should be made to take right out, or let down. If a properly constructed sun parlour with a wire floor can be provided, so that the birds can get into the fresh air, so much the better. Five to six square feet per bird for birds being intensively kept is not too much space to provide for them. Four square feet will do for birds kept semi-intensively. Intensive houses may be of the lean-to type, or the full or three quarter span. It is advisable that they should be built up at least a foot from the ground, or high enough to allow a terrier to work under them if necessary. It is a good plan also to surround the building with small mesh wire-netting nailed to the sides of the building above floor level, and let into the ground about one foot or eighteen inches. It should then be turned and carried outwards from the house. This is an excellent way of dealing with rats that are likely to burrow. In these houses each bird should have some nine inches of perching room, and one nest should be provided for every four birds.

The Battery Method.

The Battery method of keeping laying birds is the latest innovation in the intensive system. It means penning the birds in cages (one bird to a cage) for the whole of their laying life. It may be said, "Here are factory conditions applied to poultry farming with a vengeance." One can see the old poultry farmer holding up his hands in horror. In spite of much criticism, it is a system which seems to have come to stay. Results have so far shown that under good management a satisfactory egg yield can be obtained, and equal to that reached on any of the other systems.

Any charge of cruelty seems falsified if a battery house is visited. The birds appear to be quite happy and comfortable. As can be readily understood, it is necessary that only virile, healthy birds should be kept on this system, and only those rations used which are especially made up for birds kept in confinement. The cages must be housed in a suitable building, where maximum light is obtained, and the ventilation is satisfactory. The rows of cages must also be well spaced so as to allow for plenty of room for the poultryman to do his work properly. The cost of the building plus battery makes this system more costly than the others.

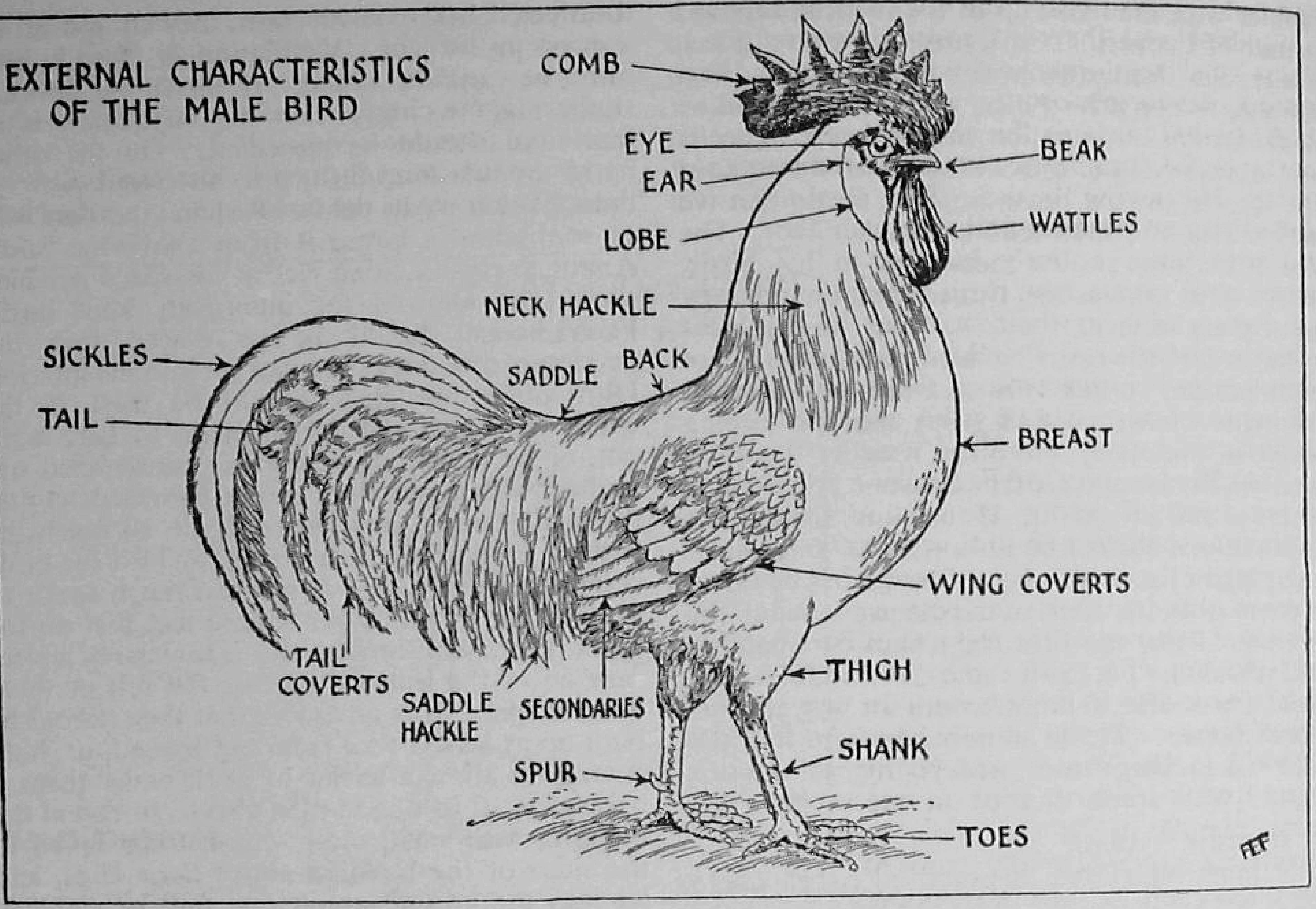


FIG. 4.—General Characteristics of the Male Bird.

THE HEN AND THE EGG

Being a description of the external characteristics of the bird together with details of the internal organs, including the digestive system and the reproductive system. Details of the composition of the egg and blemishes which occasionally arise.

Origin.

IT is generally accepted that our domestic fowl originated from the jungle fowl of India. By changes in condition, feeding, selection, and mating in the past, increase in size has been attained combined with greater fecundity. The jungle fowl would lay only about 25 eggs in a breeding season, and would weigh between three and four pounds. The present day layer will scale between five and six pounds and may lay up to 250–300 eggs in a year. She would in fact be rejected from the flock if she did not do better than produce 150 eggs annually.

Whilst no attempt can be made in a general book on poultry of this character, to go fully into the question of the science of the life (the biology) of the fowl, it is felt that some knowledge of the make-up of the hen and the egg will be acceptable and advantageous to the poultryman.

External Characteristics.

Our illustration here (Fig. 4) is not, as a matter of fact, of a hen at all, but of a male bird. It has been used here to show one or two external characteristics (spurs for instance) that the female does not possess. The illustration practically speaks for itself. Notice the feathers and be able to distinguish between primary and secondary flight feathers. Look at the sickles, the saddle and the hackle feathers. It should be noted that in most breeds (the Campine breed is an exception), the males have feathers over certain parts of the body that are longer and more pointed than feathers in the same parts of the body of the female. Such features in animals (including birds) are termed " secondary sexual characters." In fact, secondary sexual characters are features of the body which though not themselves part of the reproductive system of the male or female, are nevertheless typical of that sex and are sufficient in themselves to distinguish it. The hackle, saddle, and sickles are " secondary sexual " feathers. The comb and wattles which are secondary sexual features are outgrowths from the skin.

The openings of the nostrils (external nares) should be noted above the tip of the beak. The ears can be found by separating the feathers behind the eyes. Notice the scales on the legs and the shanks, and the spur, peculiar to the male bird. The latter of horny character is an outgrowth of the bone.

Internal Structure.

All poultrymen should make themselves

familar with the make up of the fowl, if only as a matter of interest. It is useful, however, to help one recognize changes in any of the organs due to disease. When a bird dies, if it is not wanted for post-mortem examination, it should be dissected and examined, the appearance and structure of the various organs being noted. To do this is a very useful and instructional practice, if the time can be made available. The knowledge gained can be of great service.

In order to open a bird for examination, pluck the feathers from the breast, in fact from the whole of that side, and place it on a board, breast upwards, and fasten it down, say with nails. If the skin is lifted, one should be able with a sharp pair of scissors to cut through it down from the neck to the cloaca or vent. Turn the skin right back and carefully cut away the flesh from the sides of the sternum or breast bone. Lift the sternum and after detaching the underlying organs with some blunted instrument, remove it. If the lining or membrane is then carefully removed the organs will be seen in position.

The heart, conical in shape, will be found in the middle of the body. The pointed end faces backwards. The lungs, red in colour, lie between the ribs behind the heart. If the skin of the neck is removed it will be easy to see the windpipe up to where it opens into the back of the mouth.

The liver can be distinguished by its reddish brown colour.

The alimentary or food canal, can be traced from the mouth to the cloaca or vent. The part of the food canal which begins at the back of the mouth is known as the oesophagus or gullet. It passes through the neck, opening into the stomach or proventriculus. The crop will be found as an enlarged portion of the oesophagus at the base of the neck.

The proventriculus or stomach comes between the oesophagus and the gizzard. It will be identified as being larger than the oesophagus and is reddish in colour. The gizzard is the fowl's grinding machine. It has thick muscular walls, as will be seen if it is cut open. The food is ground between the horny lining of the gizzard and the grit consumed by the bird, which will be found in the gizzard when it is opened.

The small intestine is a long tube extending from the gizzard to the caeca. These latter are a pair of blind ended tubes which mark the beginning of the large intestine. The large intestine extends from the caeca to what is known as the cloaca. This is a cavity into which the large intestine opens.

In the first loop formed by the small intestine, which is known as the duodenum, is a long gland, the pancreas. This is a compact pinkish organ. The small greenish body against the liver is the gall bladder. This stores some of the bile which helps in the digestion of some of the fats contained in the food. A duct leads from the gall bladder to the duodenum.

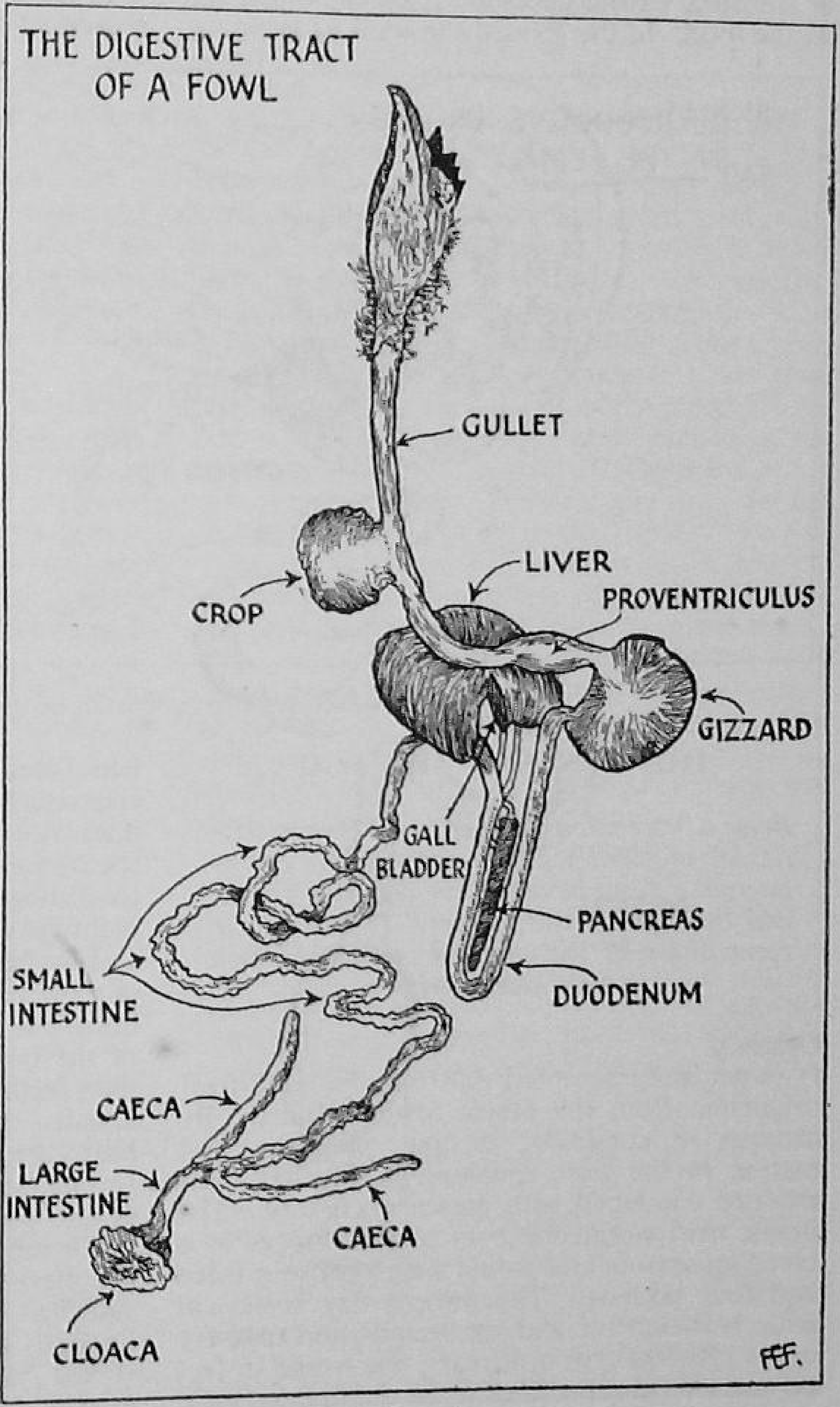


FIG. 5.

Digestion.

If the bird's mouth is examined it will be seen

that it has no teeth. Any food picked up in the beak is carried into the gullet by the tongue, and from there into the crop. This crop serves the purposes of a food store, and it is here also that grain undergoes a softening process from saliva coming from the glands of the mouth. When food passes from the crop into the proventriculus or stomach, gastric juices are released, which act on the food. In the gizzard the food by grinding is gradually reduced to a fine paste, the gizzard making up for the lack of teeth in the bird. As a paste the food passes into the small intestine, where the process of digestion begun by the action of the saliva and the gastric juices is continued by bile and pancreatic juices. Bile is stored in the gall bladder until required in the small intestine. The effects of all these juices is to convert the proteins, fats, carbohydrates and mineral salts into forms which can be absorbed by the small intestine. During the passage through the intestine the soluble contents of the food so broken down are absorbed through the walls of the intestine, the material which reaches the end of the food canal being the indigestible food residues.

In the male bird the essential paired organs of reproduction are the testes or testicles, which in a mature bird will easily be seen, one on either side of the backbone, just above the kidneys and below the lungs; the vas deferens or sperm duct is a tube leading from each testicle to the cloaca.

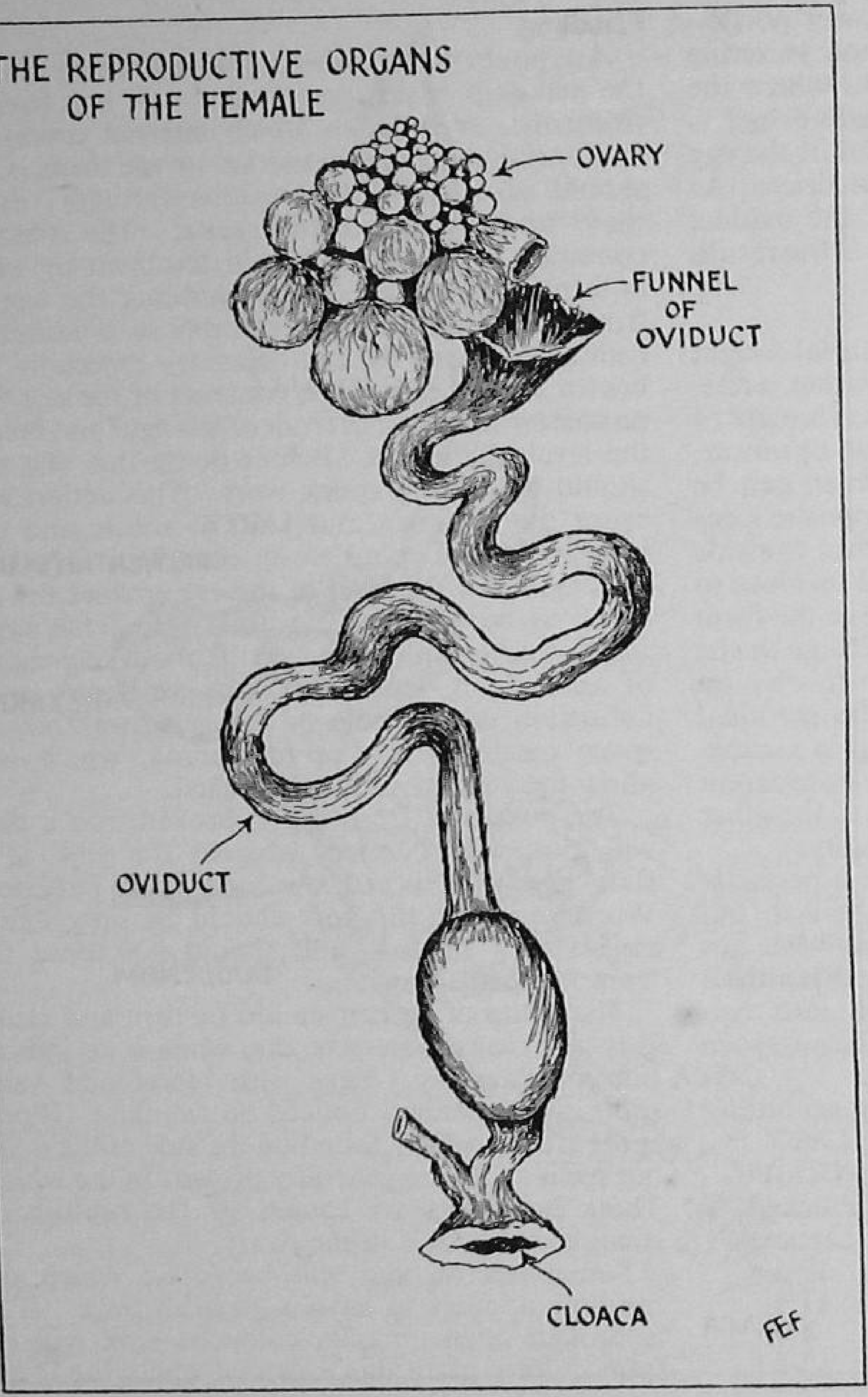


Fig. 6.

Development.

In the female bird, the organs of reproduction consist of an ovary and an oviduct. The ovary produces the yoke of the egg or ovum, and the oviduct forms the white of the egg and the shell. These may be seen after the organs of the digestive system have been removed. The oviduct is the passage along which the eggs pass from the ovary to the cloaca. The yolk of the egg develops first, and this takes place in the ovary. The ovary will contain hundreds of very tiny yolks. These yolks will be found in all stages of development. Each yolk is enclosed in a sac or follicle, through which nourishment is obtained during development, such nutriment being supplied by the hen from the products of the food she has digested and being brought to the ovary by the blood. Each yolk is surrounded by a thin skin known as the vitelline membrane. This can be seen if the egg is broken into a cup. It prevents the yolk mixing with the white. On the surface of the yolk of a fertile egg a small circular area, the "germinal spot," will be seen. This is the beginning of the development of the chick. If an egg is hard boiled and the white removed, a depression will be noticed in the inner surface of the white, and a corresponding elevation appears on the yolk; this is the place where the actual chick is developing. When the yolk becomes ripe or mature it breaks away from the covering of the ovary, and enters the mouth of the oviduct. There it commences its passage through the oviduct where various glands secrete the albumen—that is, "the white" of the egg. This is poured round the yolk, but owing to the rotation of the latter it becomes twisted at the ends, forming the chalazae. About

40 per cent of the albumen or white of the egg is supposed to be supplied as the yolk passes through the upper half of the oviduct.

After the yolk has passed some way down the oviduct the shell membrane is produced by the membrane-secreting portion of the oviduct, and a good deal more albumen is added. Here the egg is beginning to take on its final shape and size. It will have taken about three hours to pass through the first part of the oviduct and will remain from 12 to 18 hours in the lower portion of the oviduct. From the membrane secreting portion it passes into the shell gland where the shell is laid on. Finally the complete egg is expelled through the cloaca. The shell of the egg when first laid is moist, but it soon dries. As stated elsewhere, if two yolks enter the oviduct at the same time a double yolked egg is the result.

The Egg.

The hen egg is oval in shape, the usual weight being about 2 ozs. The shell will be either white, brown, or tinted. It is composed of carbonate of lime. If a fresh egg is broken into a dish or saucer, the chalazae and the layers of albumen can be seen. The chalazae are attached to opposite sides of the yolk and extend into the albumen towards the ends of the egg, or may be twisted up close to the vitelline membrane. The chalazae in the form of long threads, prevent any quick change in the position of the yolk and causes it to revolve on the long axis of the egg, keeping the germinal disc on the upper side, nearest the heat in incubation. The dense layer of albumen is transparent and, in a fresh egg can be seen, as well as the other two layers. The outer layer looks watery.

The shell membrane is double. In a perfectly new laid egg the shell is completely filled, but after it has been laid for some time and has got cool there is a certain amount of evaporation and the double membrane separates into two layers at the large end of the egg and the air-space is thus formed.

The composition of the hen's body according to Cambridge data, is:—

	Body including feathers	Plucked carcase
Protein (or flesh) .	24·8	19·3
Fats . . .	12·8	13·5
Ash . . .	4·0	4·4
Water . . .	58·4	62·8

The average composition of the new laid egg, according to Cambridge data, is:—

	Per cent
Yolk	33·1
White . . .	57·8
Shell	9·1

The chemical composition of the entire egg is:

	Per cent
Protein . . .	10·9
Fat	10·5
Ash	0·9
Water	68·6
Shell	9·1

Candling.

All poultrymen should know enough about the make-up of an egg to tell a stale one from a fresh one, or those in which internal condition makes it undesirable to market or use them. One should also know the reasons through which these undesirable qualities arise. The internal condition of an egg can be determined by what is termed candling. This is holding the egg in front of a bright light, preferably in a darkened room. A strong light is necessary especially for brown shelled eggs. The contents of the egg will be seen by placing it in front of the light and below the level of the eye. Before doing this, the egg should be given a quick twirl. This action will cause the albumen and yolk to rotate and the interior will be more easily observed. Holding the egg below the level of the eye enables the air space to be seen more readily. In fresh eggs, the air-space will only be small, about one-eighth of an inch in depth. A large air space is an indication of staleness or age. A movable air space means a broken membrane, which will allow the yolk to stick to the shell.

The yolk of a fresh egg if broken into a dish will look well-rounded, whereas the yolk of a stale egg will spread out and look flattened. When candling, the yolk should be only dimly visible as a shadow, and should not move far from its normal position.

The white of an egg should be firm and clear. It is said that a watery or thin white is an indication of staleness. Eggs with blood and meat spots are sometimes noticed on candling. Blood spots are frequently found on the side of the yolk, but meat spots are generally present in the white. These egg faults are caused by the rupture of small blood vessels in the ovary.

Sometimes an egg will be found which on candling appears to have a greenish tinge. If it is broken open an olive-coloured yolk will be found. Very often this is caused where the fowls on range have discovered and eaten shepherd's purse, or other weeds of a similar kind.

Shell-less eggs are produced as a result of not giving the hens a sufficient supply of oyster shell or limestone grit. Double yolked eggs are not the result of disease, but occur when two ova are passed from the ovary into the oviduct at approximately the same time.

BREEDS AND BREEDING

An account of the various breeds in general use, with some old time favourites, and a few foreign table breeds. The use of cross breeds. Sex linkage. The management of Breeding Stock.

Choosing a Breed.

In selecting a breed or cross-breed, the poultryman should obviously be guided by the experience of others. As a farmer he may have his likes and dislikes. The colour or shading of a particular breed may appeal to him. If he is not particular about making a living from his birds, he can probably indulge his fancy. Should he be out for business, however, then he will look to the popular breeds, for evidence of popularity will be found in ability to prove a money maker. True, some of the breeds described as fancy breeds now, have been popular in the past, but they have been outstripped by others of greater utility value.

The table set out in this section makes no attempt to name all the breeds, but whilst giving those to be found on our holdings in this country, it must also include some that have been found useful for crossing. Others are named that have been of proved utility in the past, and might well come into their own again. Naturally, the poultryman in choosing a breed will have in mind exactly what branch of the industry he intends to take up. Certain varieties are excellent layers and nothing else and in these cases the cockerels do not prove a profitable proposition if fattened for the table, nor will the layer itself make much at the end of egg production, and is generally not worth fattening. These layers are the non-sitting varieties.

Then there are the general purpose breeds, both egg producers and good table birds, very useful to one who, wishing to have an egg farm in the main, would also like to rear the cockerels for table. As layers some of the general purpose breeds run the laying varieties very closely.

Table-poultry farmers will look for breeds known for their table qualities, but will also want to choose from those which mature quickly and fatten satisfactorily.

It would probably not be an exaggeration to say that the first four varieties named above would be found on three-quarters of the poultry holdings in this country to-day.

Plymouth Rocks, Anconas, and Campines are not very numerous, although the first named is kept in large number in Canada.

The Minorca and Houdan, once popular, are not now in favour on commercial holdings.

The Dorking, Game, Orpington, Faverolle and La Bresse are kept for table production or for crossing for that purpose, though the Orpington is also by no means a bad layer.

Some mention must be made of one or two breeds from abroad which will be found on some holdings here and which are evidently giving satisfaction. Of such are the Dutch Barnevelder and Welsummer, layers of large rich brown eggs, and the North Holland Blue, a general purpose breed. The Belgian and French Table Breeds, Malines, Crève-cœur, and La Fleche are much favoured white flesh breeds on the continent.

Name of of Breed	*Country of of origin*	*Comb*	*Colour of flesh and skin*	*Colour of egg shell*	*Colour oj of legs*	*Remarks*
Rhode Island Red	America	Single	Yellow	Tinted or Brown	Yellow	General Purpose Breed
Sussex	Britain	,,	White	Tinted	White	,,
Leghorn	Italy	,,	Yellow	White	Yellow	Laying Breed
Wyandotte	America	Rose	,,	Tinted	,,	General Purpose Breed
Plymouth Rock	America	Single	,,	,,	,,	,,
Buff Rock	America	,,	,,	,,	,,	,,
Ancona	Italy	,,	,,	White	,,	Laying Breed
Campine	Belgium	,,	White	,,	Slate	,,
Minorca	Spain	,,	,,	,,	White	,,
Houdan	France	Leaf	,,	,,	Pinky White	,,
Dorking	Britain	Single (except White	,,	,,	White	Table Breed
Game (Indian)	Britain	Pea	Yellow	Tinted	Yellow	Table Breed
Game (Old English	Britain	Single	White	,,	White	,,
Orpington	Britain	,,	,,	,,	,,	General Purpose or Table
Faverolle	France	,,	,,	,,	,,	,,
La Bresse	France	,,	,,	White	Slate	Table Breed

Rhode Island Red.

Of all the breeds used on commercial holdings now, probably by far the most popular and numerous is the Rhode Island Red. The single combed variety is supposed to give better results than the rose combed group. It is of a rich chestnut colour, and has proved an excellent

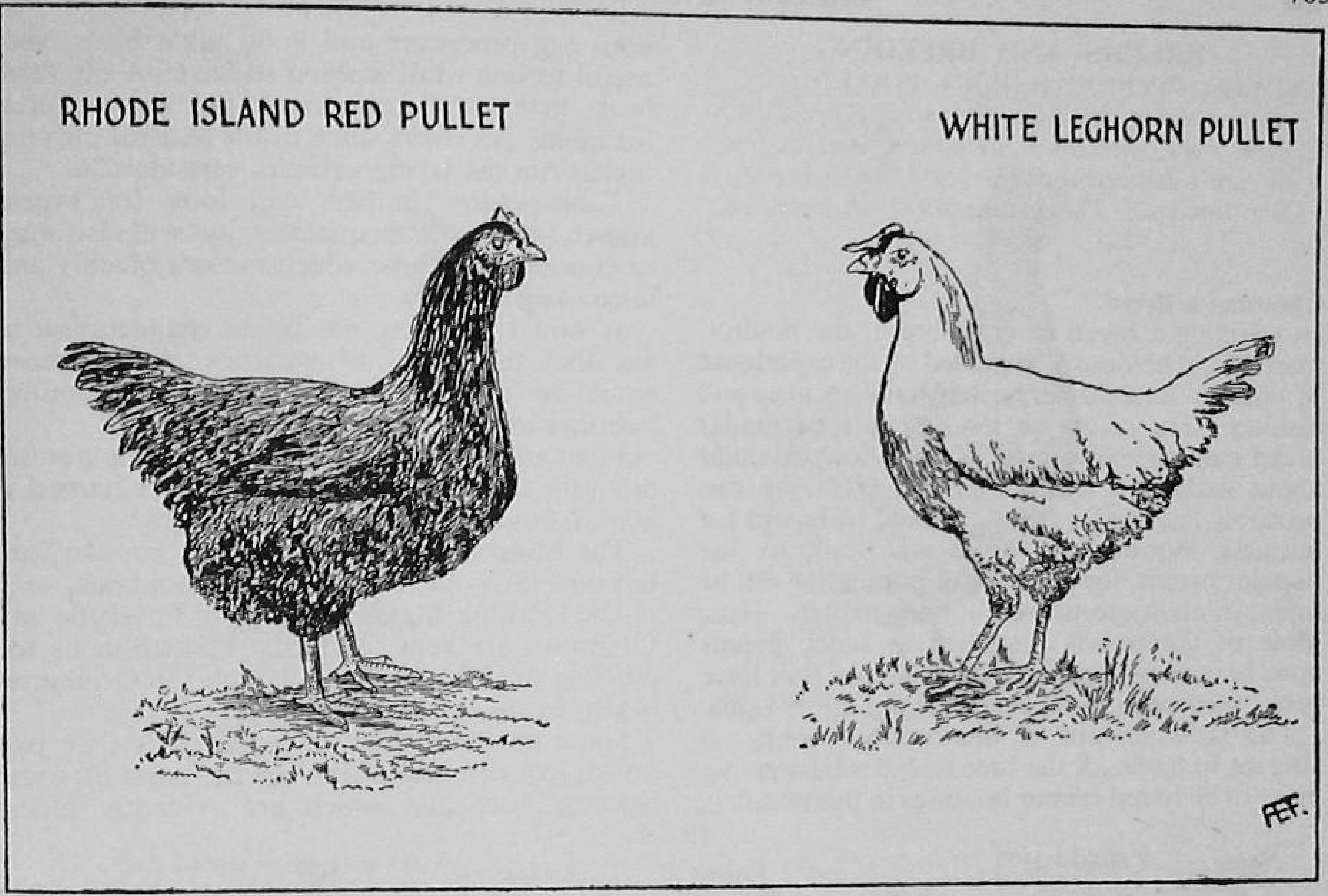


FIG. 7.

One of the most popular breeds. Layer of large white eggs.

layer when kept on various systems. As a table bird it has good qualities, and if it were not for its somewhat high breast-bone and the popular prejudice in favour of white flesh, would command top prices. As it is, when crossed with Light Sussex females (a sex-linked cross)—sex-linked is explained later in the present section—the progeny come with white flesh to about 90 or 95 per cent, and cockerels for the table from this mating are in popular demand in the best market.

Until comparatively recent times the Sussex was not thought of as a layer but purely for its table qualities. It is still considered by most fatteners the best breed for the table. Now the Light Sussex variety, but not the others, viz., Red, Brown, and Speckled, has been developed for its laying qualities, and recent laying trials have shown its worth as a good layer of tinted shelled eggs. Its plumage is white, with black ticking on the neck and it has a black tail. As already stated, when crossed with a Rhode Island Red, it still retains its excellent table qualities and white flesh.

The Leghorn belongs to the non-sitting light breeds. Of the various classes within the breed, the best known in this country are the White, Brown, Black, and Buff. The White is by far the most numerous, though it does not hold favour with the egg farmer as much as formerly, having been ousted by the Rhode Island Red. The Black Leghorn can now be found amongst the leaders at laying trials. The Brown or Buff Leghorn crossed with the Light Sussex produces sex-linkage, as does the Black Leghorn crossed with the Barred Rock.

The Wyandotte (the white variety of which was in such great favour a few years ago) seems to have suffered an eclipse. It is hoped that this will be only temporary for it is an excellent dual purpose bird, a prolific layer and by no means a bad table bird. The Silver and the Columbian are other types of Wyandotte, but are not as popular as the White variety. The Wyandotte makes a good broody hen.

The Plymouth Rock, or Barred Rock as it is sometimes called, has grey feathers barred with white. Though its egg production may not be as high as the breeds named above, it is a very useful layer and a good table bird. The Buff Rock is considered a better layer than the Plymouth Rock, in other respects it is similar.

Among laying breeds is the Ancona. It is very similar to the Leghorn in shape and has black feathering splashed with white.

The Campine, of which breed there are the Gold and Silver varieties, is a good layer. With its gold and silver pencilled colouring, it has a greyish white flesh.

The Minorcas were very popular in this country some years ago, but they are not now found on commercial holdings. Perhaps their slow rate of maturity was against them, and they do not seem to have been bred for utility purposes. The

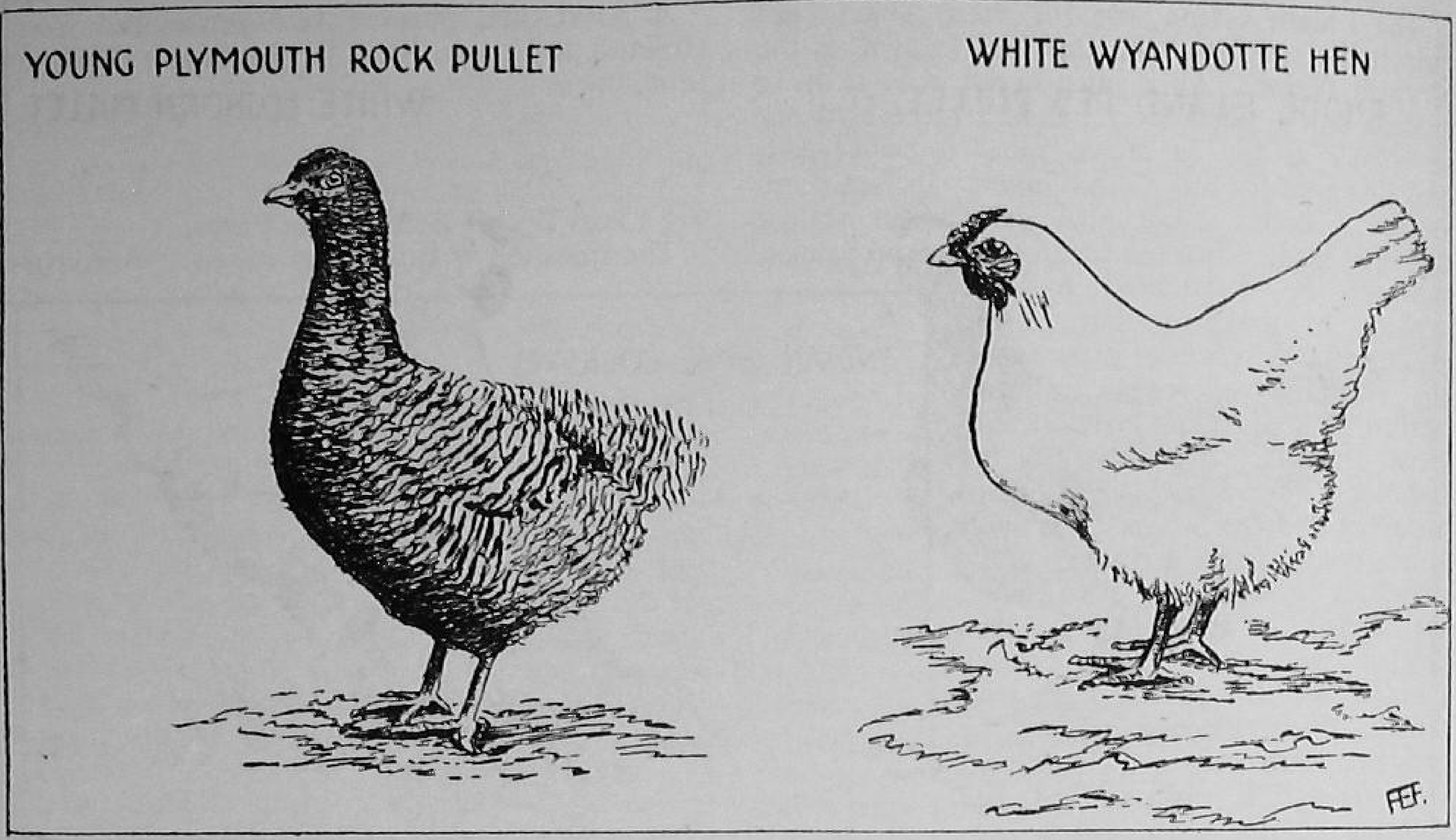


FIG. 8.

A good laying breed. A good layer of tinted eggs.

plumage of the Minorca is a glossy green black. It produces white eggs of excellent size, and also makes a fair table fowl.

The Houdan is another breed very popular in the past, but not in favour now. One remembers it is a breed that for quantity of flesh to bone and offal, and as a layer of large white shelled eggs, was hard to beat. Perhaps certain drawbacks reacted against its use on a large commercial scale. A cold damp situation seems to have an adverse effect on it, and it is not helped by its large head-dress of feathers. The plumage of the Houdan is a glossy green black ground mottled white.

Table Birds.

Of breeds usually used for table purposes, the best known—and as it happens they are all of British origin—are the Dorking, Orpington and Game. The Faverolle from France (a fair layer) is also an excellent table bird. The Dorking, Orpington and Faverolle are large-framed birds. A good table breed of smaller size, also of French origin, is the Bresse. It would be difficult to find any of these breeds run on commercial table plants to-day, though they might very well be seen crossed with more popular breeds. As pure breeds various factors react against their being used commercially, for instance lack of eggs in sufficient numbers, slowness in maturity, or perhaps their want of hardiness. Be this as it may, as first-class table birds they cannot be beaten, and where crossed with other breeds, tend to impress their excellent table qualities on the progeny.

The Dorking consists of several varieties, dark or coloured silver grey, white and cuckoo. The Silver Grey is the best known. This, when fully mature, makes a very large table bird of fine quality, reaching weights up to ten pounds. The Dorking has five toes, and the White variety has a rose comb, the others having single combs. The plumage of the Silver Grey is many coloured with black and white predominating in the male, and the female having a salmon-red breast shading into grey on the back and wings.

The Orpington owes its origin to Mr. W. Cook of Orpington in Kent. There are now several varieties, including the Buff, Black and White, The Buff Orpington has been the most popular in the past. It makes an excellent table bird when properly finished, and carries a large amount of flesh. As with most of these good table breeds, it does not do well on heavy wet soils. Where it is crossed with the Sussex a very nice table bird is produced.

Game Fowls.

There are several breeds of Game Fowls, the two chief ones kept in this country now for poultry purposes being the Indian Game, and the Old English Game. This is the breed kept in the past purely for sport, being used for cock-fighting. Its fame in this direction, as far as England is concerned, is happily a thing of the past, cock-fighting being prohibited by law, and now only heard of occasionally when a main held in secret is discovered by the guardians of the law.

The Indian Game was for many years kept principally in Cornwall, and was known as the Cornish Game. As a pure breed it is slow to mature and a poor layer. It is a table bird *par excellence* as far as breast meat is concerned, and this goes for any Game breed. In fact there is not a better table bird despite its yellow coloured skin. Since the commercial aspect must, however, be considered by one wishing to make a living from poultry, the slowness of growth and the shortage of eggs militates against its use. When crossed with other breeds, the Sussex for instance, its value is at once apparent and quickness of growth is achieved in the progeny. One drawback noticed at Wye when the Indian Game (male) was crossed with the Light Sussex (female) was the rather high percentage of infertile eggs during the early part of the season. The Indian Game is a fine looking bird, the plumage having green black predominating, with some chestnut or crimson. Crossed with the Sussex about 85 per cent of the progeny will carry white flesh. Incidentally this cross shows sex linkage. The Old English Game is a hardy bird; it is an excellent table fowl and a better layer than the Indian Game. In crossing, though it will not produce such a large fowl as Indian Game, the well fleshed breast is more delicate in quality. It also has the advantage from a table point of view of possessing white flesh. The plumage of the Old English Game is varied red, blue red, mottled or spangled.

The Faverolles combine large size with early maturity, good egg yield, and fine white flesh. The most common in this country is the Salmon Faverolle. As its name implies the colour of its plumage is salmon or salmon buff. Used in crossing with the Sussex, a very fine table bird is produced.

French Breeds.

Of the other French breeds the La Bresse is perhaps the best known over here. There are several varieties, black, white, grey and blue. The White is probably the most popular. It has been said in recent years that there is, or would be, a popular demand for a table bird or about 2½ or 3 pounds. Should this ever prove to be the case then the White La Bresse with its fine bone, good breast, and excellent white flesh, should go far to meet the demand.

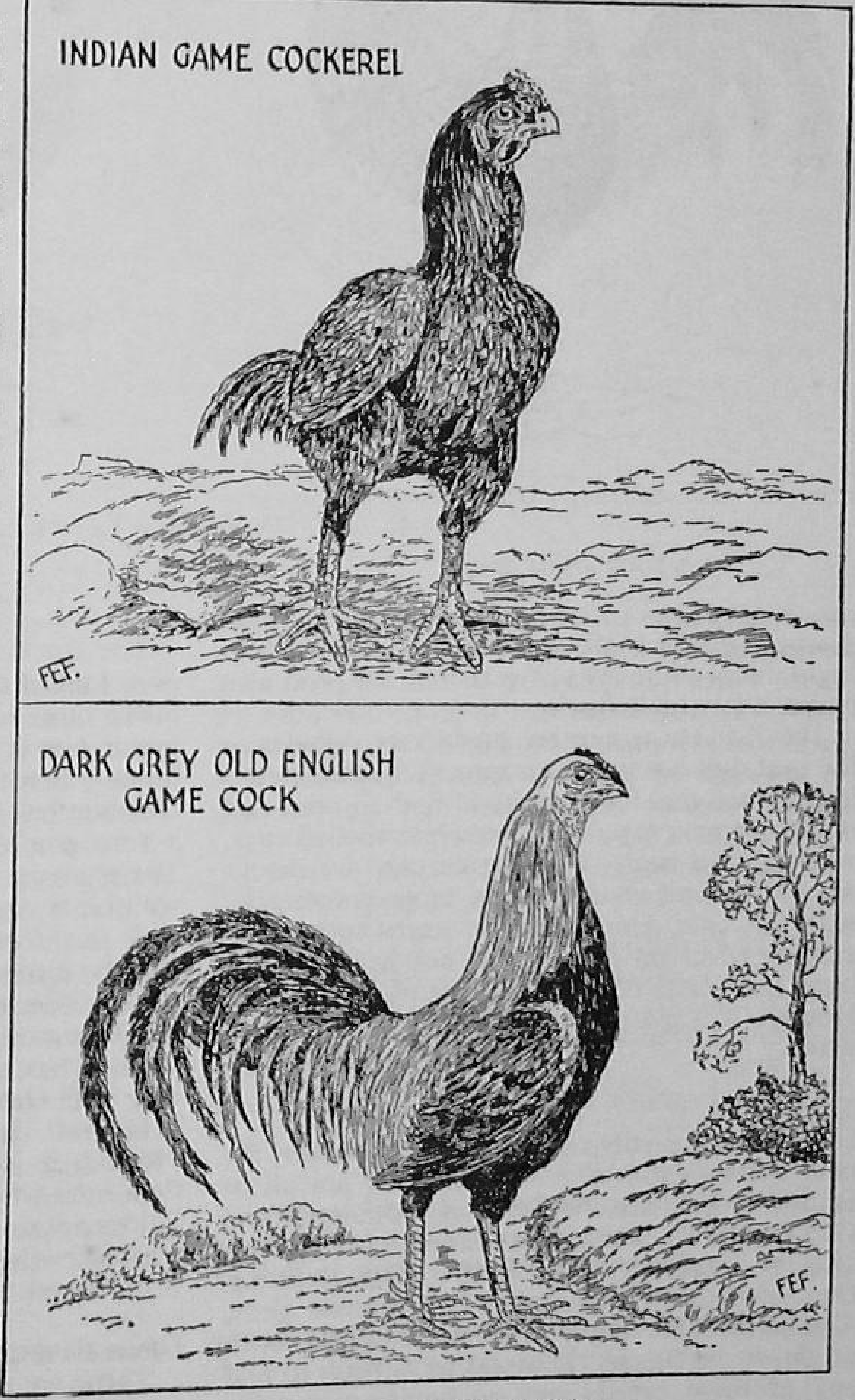


FIG. 9.—Possess good table qualities.

A good dual purpose bird introduced from Holland in recent years is the North Holland Blue.

CROSS BREEDS.

Are Cross Breeds Better Than Pures.

The question is sometimes raised, " Are cross breeds better than pures? " The point at issue really is, " Are they a better proposition from a commercial standpoint? " It will probably be found that given good birds, a cross between two breeds will give stronger chickens, which will rear with lower mortality, they may grow quicker and hardier, the cockerels making good table birds, and the pullets equally good layers. In

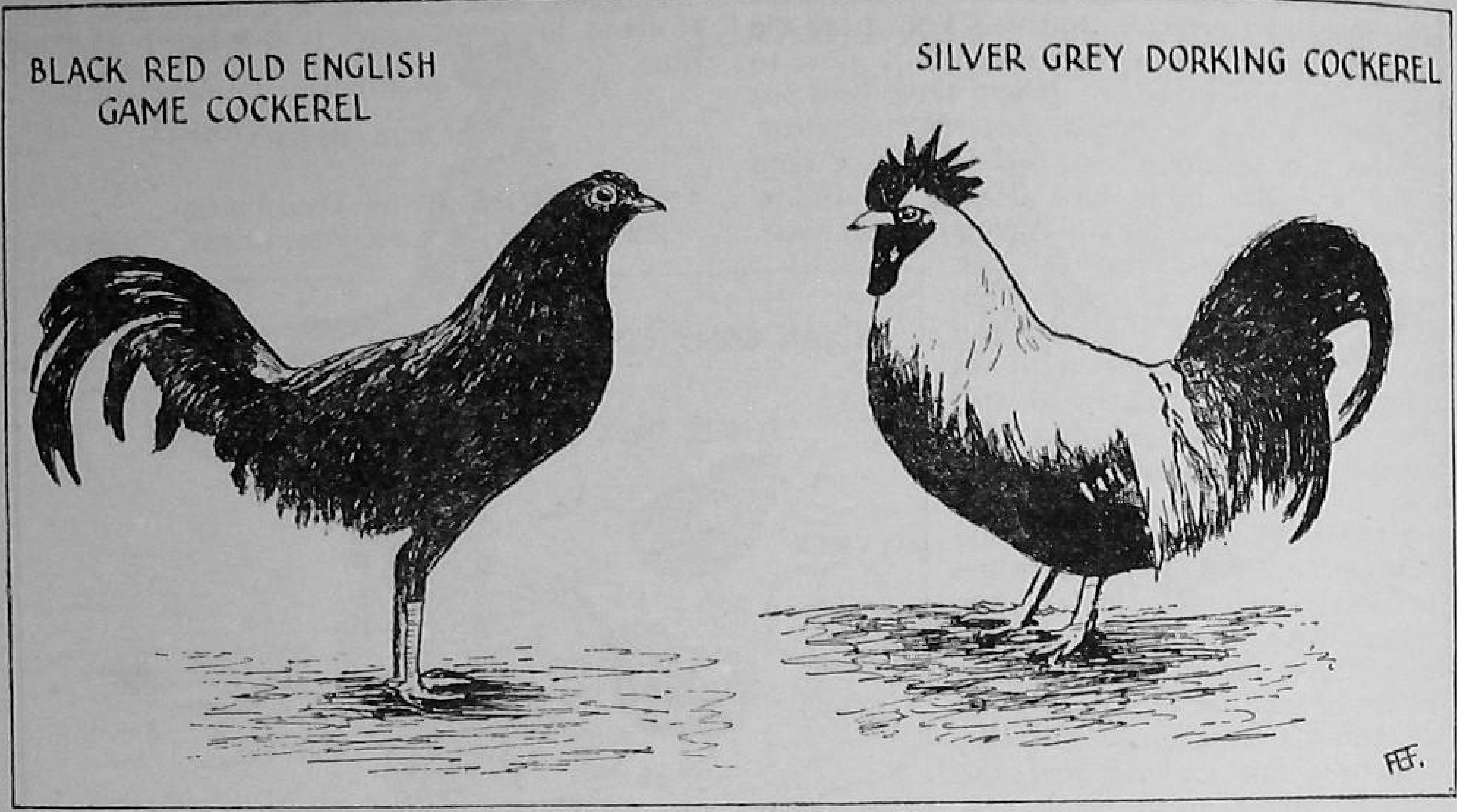


FIG. 10.—Well-known Table Birds.

deciding to keep a cross breed a poultryman must remember that it would be unwise to breed from them. Pures would have to be kept for producing the stock. It is better not to go further than the first cross as a rule. It should also be remembered in any sale of hatching eggs or day-olds, it is either pures or first crosses that are generally required.

Some possible crosses are:—

For Egg Production:—

- White Leghorn crossed with a White Wyandotte.
- White Leghorn crossed with a Rhode Island Red.
- White Leghorn crossed with a Light Sussex.

For Table Poultry Production.

- Indian Game crossed with a Light Sussex.
- Old English Game crossed with a Light Sussex.
- Old English Game crossed with a Salmon Faverolle.
- Old Engilsh Game crossed with a La Bresse.
- Silver Grey Dorking crossed with a Light Sussex.
- Orpington crossed with a Light Sussex.
- Salmon Faverolle crossed with a Light Sussex.
- La Bresse crossed with a Light Sussex.

For Egg Production and Table Poultry Production.

- Rhode Island Red crossed with a Light Sussex.
- Light Sussex crossed with a Rhode Island Red.
- Rhode Island Red crossed with a White Wyandotte.

SEX LINKAGE.

Sex Linked Characteristics.

To research workers in poultry problems a great debt is due for many discoveries which have done much to improve and simplify the work of the poultry farmer. One of the most important of these in recent years has played, and will play a big part in the development of the industry. It is that by certain matings, characteristics come out in the progeny whereby the pullet chickens can be distinguished from the cockerel at day old. It requires little imagination to see what a big step forward this is. The commercial egg farmer simply has to rear his pullet chicks, disposing of the cockerels at once to a table holding, where cockerel and not pullet chicks are required. Brooding and rearing equipment is halved, or alternately more pullet chicks can be dealt with at one time, thereby shortening the hatching and rearing season, or allowing for the production of a larger head of stock.

Parents and Progeny.

How is this sex-linked characteristic brought about? Research workers have found that any hen carrying silver plumage, transmits this silver colour to her sons and gold to her daughters, whereas a cockerel of the same breed transfers the silver colour to both cockerels and pullets. Silver being dominant to gold as far as poultry is concerned, if a bird receives silver inheritance from one of its parents, it will be silver itself even if it receives gold inheritance from the other parent. If a pure Light Sussex cock or cockerel,

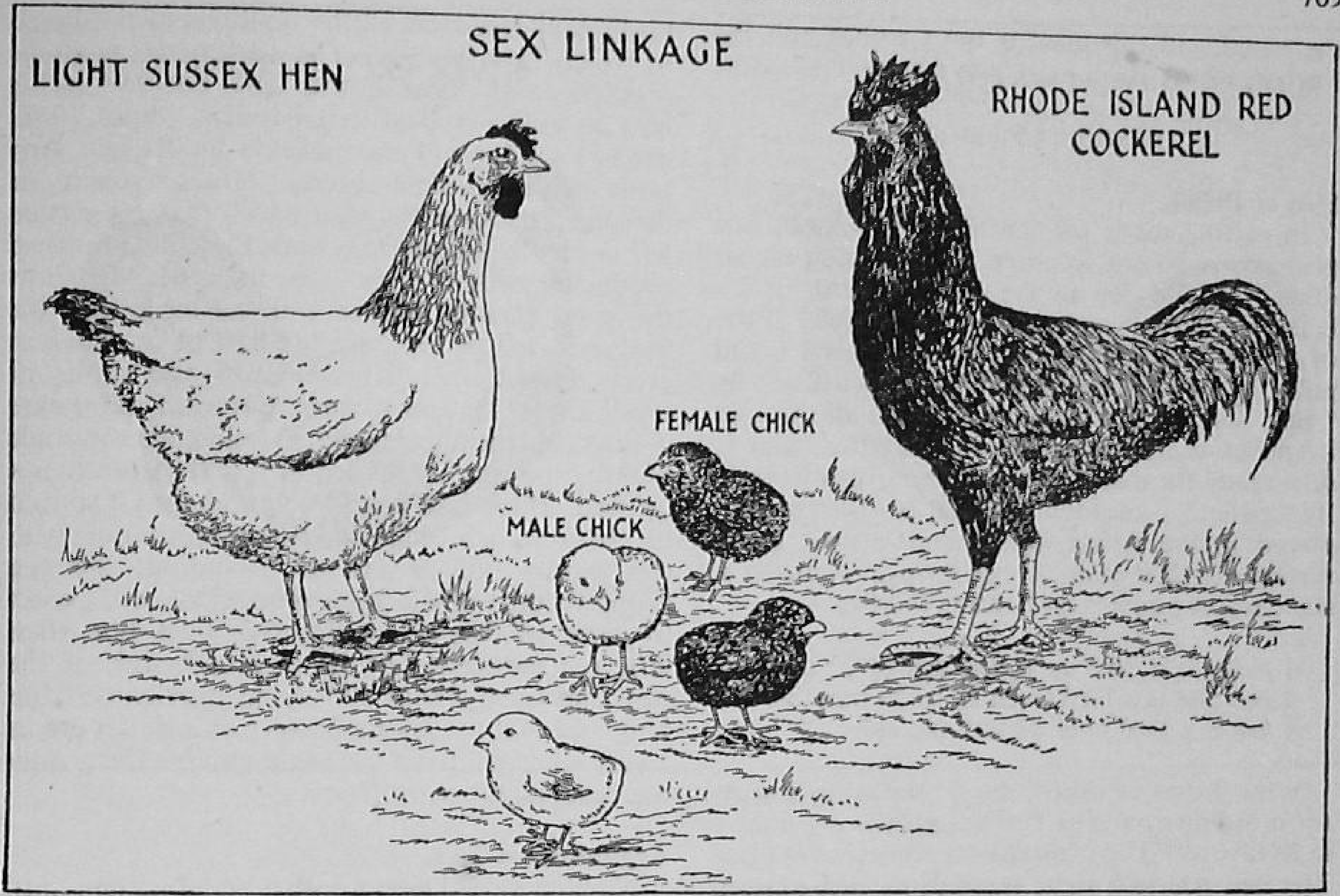


FIG. 11.

which belongs to the silver class, is mated to a Rhode Island Red hen, a breed of the gold class, it will be found that all the progeny will be silver. The silver colour they get from the father is dominant to the gold of the mother. If, however, the mating is done in the reverse way, by mating a Light Sussex hen with a Rhode Island Red cockerel, all the cockerel chicks will be silver, and all the pullet chicks gold or dark coloured similar to the Rhode Island Red father. The Light Sussex hen transmits the silver colour to her sons alone. To her daughters she transmits gold. The Rhode Island Red cockerel transmits gold to all of its offspring, the pullets receiving gold therefore from both parents. The pullets will grow up like the Rhode Island Reds and the cockerels like the Light Sussex. The Rhode Island Red is spoken of as belonging to the gold class. Its plumage of course is not gold but a brownish red, but it belongs to the gold class as does the Brown Leghorn, Indian Game, Dutch Barnevelder, the Red Sussex, Buff Rock and Buff Orpington. Likewise to the silver class belong not only such silver breeds as the Silver Wyandotte and the Silver Campine, but breeds in which the colour of the down is creamy silver, as the Salmon Faverolles, and the Light and Dark Dorking.

Sex-linkage is also obtained by mating a pure Plymouth Rock hen with a black cock or cockerel, say a Black Leghorn or Black Minorca. The distinction can be seen at hatching, for the cockerel chicks which will grow into barred birds will show a light patch at the back of the head. This will not be found in the pullet chicks which will grow up with black plumage.

Some Breeds giving the Sex Linked cross, are:—

- Rhode Island Red (male) crossed with a Light Sussex (female).
- Rhode Island Red (male) crossed with a White Sussex (female).
- Rhode Island Red (male) crossed with a White Wyandotte (female).
- Buff Rock (male) crossed with a White Wyandotte (female).
- Buff Rock (male) crossed with a Light Sussex (female).
- Brown Leghorn (male) crossed with a Light Sussex (female).
- Brown Leghorn (male) crossed with a White Wyandotte (female).
- Buff Leghorn (male) crossed with a Light Sussex (female).
- Buff Leghorn (male) crossed with a White Wyandotte (female).
- Wellsummer (male) crossed with a White Wyandotte (female).
- Black Leghorn (male) crossed with a Barred Rock (female).
- Indian Game (male) crossed with a Light Sussex (female).
- Indian Game (male) crossed with a Faverolle (female).

In recent research work it has been discovered that it is possible to produce sex linkage within

the breed. In this class is the Cambar and the Legbar, which are coming into commercial work.

Breeding Problems.

Hen or Pullet.?

In getting ready for the breeding season, one problem is bound to come up at some time or other: Should one always insist on hens for the breeding pen or would pullets do as well? First of all, what exactly is meant by the terms hen and pullet? For the purpose under discussion, by " hen " is meant a bird that has laid all through its pullet year, has rested and moulted, and is now ready for a second season's egg production. By " pullet " is meant a bird that has been reared, placed in the laying house, and is now going through its first year of egg laying. Actually a standard has now been fixed as follows:—

A pullet is a bird up to the age of 12 months.
A yearling is a bird from 12 to 24 months.
A hen is a bird over 24 months old.

Why, it may be asked, should the use of pullets for breeding ever arise? What are the arguments in its favour? The main reason is number of eggs. The hen has laid right through its first season, has done well, and the early breeding period comes along when it is only just through the moult. Eggs are in short supply. On the other hand the pullet is in its first flush of egg production and numbers are plentiful. This matter of short supply is especially a bugbear to the producer of table poultry, for in order to catch the early and best market for his chickens he will want to start his hatching operations in the fall of the year instead of in the spring. As a matter of fact the use of pullets for breeding by the table poultry farmer need not be deprecated, since all the chicks he will hatch, or at any rate the bulk of them, will find their way to the table. If he is a wise man he will keep one or two pens of breeding hens to produce the stock he wishes to carry on for future breeding. What are the arguments against using pullets for breeding? The main one, of course, is the absence of any complete record of eggs laid, as the pullet is then only in its first year of production. Since egg records play a very large part in the selection of stock for breeding, the absence of such records can be a serious matter in building up or maintaining first-class stock.

Selecting.

Having decided the question of hens or pullets, having earmarked the best layers either by inspection of records kept in the laying houses, or by other methods of identification, there is still the question of selecting the best from these good egg producers. There are certain factors which must not be ignored. In the first place the stock must be perfectly healthy and handle well. The birds should possess all the qualities of the breed to which they belong. The undersized must be rejected—and, indeed, the ugly coarse-looking bird as well. A bird that handles " light " will not be kept nor will one that lays small eggs. Any birds with crooked breast bones, roach or deformed back, or the like, which may have been left in the laying quarters until they have finished producing, will of course be rejected. In short the good poultry keeper will see to it that the birds selected by him, are the best of the flock in every respect, free from blemish and faults of every kind. The same care, and even more care if possible, must be taken in selecting the male bird for the pen. A related bird will certainly not be used. If the bird has to be purchased it should be got from a breeder of known reputation who can supply full particulars including, the egg laying records of the sire's dam. One will expect to pay a good price for the male bird, but when it is remembered that he is nine-tenths of the pen, that some 200 or 300 chicks may come from him, and that the laying powers of a pullet are as a rule inherited from the male parent, then, only the best should be sufficient.

Agglutination Test.

No bird should be put into a breeding pen until it has been tested and satisfactorily passed the Agglutination test for Baccillary White Diarrhoea. This applies to one's own stock as well as purchased birds. Even if birds have been tested previously, they should be tested again in case of possible infection in the interim. Any birds obtained for breeding from outside sources should be purchased subject to their having passed the test successfully. Breeders of repute will sell their stock subject to this condition.

It is a common thing with some breeding establishments to require a young cockerel each year for mating with mature hens. Whilst there is a lot to recommend this practice, it is an error nevertheless, to discard a male bird after it has proved its worth in the breeding pen during its first year. Having procured a good bird, it is worth while looking after him carefully. Especially should it be seen that he gets his food properly, for he will often neglect to take his share in his desire to see that the hens get all they want. The number of hens to mate with the male bird will be different in different cases. With the Light Breeds, Leghorns and the like, it will be fifteen or twenty. Perhaps it is better to leave it at fifteen. With the heavy breeds, such as Sussex, Wyandottes and Rhode Island Reds, ten or twelve hens are sufficient. These numbers relate to birds confined in wire runs. On some commercial holdings, where breeding birds are left on unrestricted range, several males will run with the flock, and on this system more hens can be run to the male than when they are wired in. Where several male birds are running in the same flock, care should be taken to see that they are

brothers or have been brought up together. Otherwise they will fight and fertility of eggs may be upset. The main objection to flock mating is the inability to trace to any particular male a high percentage of infertile eggs. On some holdings one male bird will be used in two pens of hens, being in one pen the first day, and in the second pen the following day.

Inbreeding.

"Inbreeding," or the mating of birds related to each other is practised on some establishments. Whilst this can be done, and is done, with marked success by skilled breeders, it is not a practice to be recommended to the ordinary poultry farmer. The establishment of what is known as a strain involves "inbreeding." If related birds are mated together they are more likely to breed similar characteristics than when unrelated birds are mated. Whilst the results desired are often obtained, "inbreeding" may result in failure and disappointment. The road to success may be a long one. So no useful purpose would be served in a book of this kind in attempting to discuss in detail the problems attendant on "inbreeding."

Management.

The management of the breeding stock should follow on similar lines to that used with the laying stock. Attention should be given to routine matters:—water vessels kept clean, careful feeding, fresh litter when necessary, and a watch kept for all insect life. No attempt should be made to induce the birds to lay before eggs are desired for hatching. Often the spurs of a second year male bird will require paring. This can be done by cutting off the ends with a sharp knife and then applying a caustic stick. Removal of the comb, or dubbing as it is called, can be quickly and efficiently done with the aid of sharp scissors. The comb can be cut off near to the head. The caustic is applied after washing the wound with cold water. After about a week the bird will be quite fit and fertility should increase. Often a large and heavy comb will obscure the sight of the bird. Thus dubbing the males of the large combed breeds is found an advantage.

It is well to make up the breeding pens in good time before the eggs are required for incubation, a month ahead being a reasonable period in which the birds can get used to one another. Eggs will be fertile in about ten days or a fortnight after mating. It should be noted that they will remain fertile for about the same period after the male has been removed from the pen.

If a cockerel has been purchased from another establishment, it is advisable to buy subject to approval, and good class breeders are always ready to allow this condition. The cockerel should be kept apart from the other stock for a period. (See discussion on Diseases, on pp. 760-764).

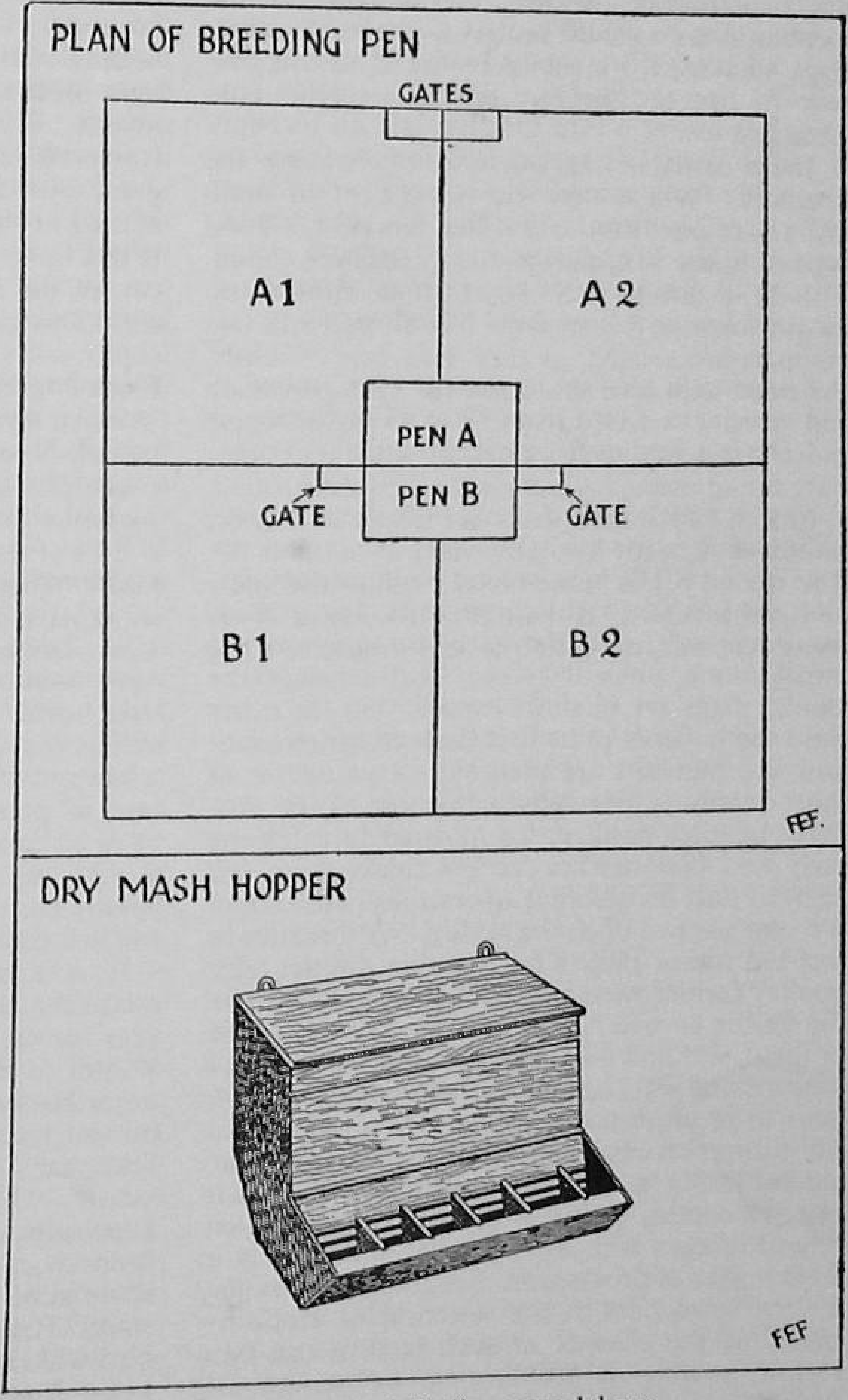


FIG. 12.—Dry-mash feeding saves labour.

The Time for Hatching.

The time of hatching season depends upon the character of the business being done. If egg production is the object then eggs from the heavy

breeds can be incubated in February and March, so as to produce pullets which will come into lay in the following Autumn. With the light breeds hatching is usually done in April and the first week in May, for the same reason. Sometimes with both light and heavy breeds a batch or two of early chicks will be brought off in January. In table-work where hatching is done nearly all the year round, the first lot of eggs for the incubator are usually required in the Autumn. Eggs intended for incubation should be collected two or three times a day during the cold weather.

There remains the question of housing the breeders. Where they are being kept in small units (i.e., one male to a dozen females), a good type of house is known as the Lancashire Cabin. This is a house with plenty of headroom and measuring nine feet square. It is divided into two compartments each to take one pen of birds. Provided with alternate runs, for each pen, each run about 45 feet square, the birds, by being moved from one run to the other when necessary, have the advantage of a change on to fresh ground.

In Fig. 12 the first pen is in the first half of the house at A, with available runs at A^1 and A^2. The second pen is in the bottom half of the house at B, with runs at B^1 and B^2. If birds at A are using A^1 pen, then the birds at B should be using the run at B^2. To put the birds in pens adjacent to one another will mean upsetting the male birds, and possibly their damaging one another through the wire.

This type of house has windows at floor level as well as higher in the walls. It is fitted with dropping boards, dry mash hoppers, water fountains, and a range of nest boxes fixed up for trap nesting, because eggs must be recorded accurately for identification purposes. The wire netting used for the runs is usually six feet for the light breeds, and a foot less will do for the heavy breeds. Sometimes with the light breeds trouble is experienced by birds flying over the wire. A good preventive is to have a length of wire netting at the top of the six feet to turn inwards. If this fails the culprit must be caught and one or two of the feathers of one of the wings must be cut. This generally proves effective.

Flock-Mating.

When birds are flock-mated it is a good plan to include an extra male with the hens. Often when cockerels are run together one of them will sooner or later get bullied to such an extent that he will be of no further use, and it is better to remove him. When this is done it will be impossible to replace him with a fresh bird because the newcomer will be treated in the same way.

INCUBATION

Natural and Artificial. Hatching by the broody hen. Incubators large and small. Hot-water and hot-air machines. How to work the incubator efficiently. Treatment of eggs and the hatching chick.

Hatching.

HEN eggs take twenty-one days to hatch out, duck eggs twenty-eight days to thirty days, turkey eggs twenty-eight days, guinea fowls twenty-five to twenty-six days, pheasants and partridges twenty-four to twenty-five days. Hatching by natural methods is not now practised on large commercial farms. This is probably owing to the extra labour entailed, the difficulty of getting enough broody hens as required, and also because it has been found out by practice that equally good results can, with careful management, be obtained by the use of the incubator. Where only small numbers of eggs are required for hatching the natural method is still used. Many will remember one successful breeder on a large scale doing all his hatching in recent years in this way. A broody hen is one that is showing signs of a desire to sit on or brood her eggs. She will visit the same nest daily, remaining longer on the nest each day until she stays there altogether. If turned off the nest she will walk about with her feathers loose and ruffled. She will also make a " clucking " noise as if calling her chickens.

The Broody Hen.

The first essential for natural hatching is the broody hen, and it will be realized that a good number would be required on a large plant. These are not so readily found when wanted as might be imagined, but for the small man there should be no difficulty.

The poultryman must satisfy himself that the bird is properly broody and will remain so. Light breeds should not be chosen for the purpose, they are not reliable. Birds from the heavy breeds and their crosses should be selected, and hens as a rule make better sitters than pullets. The coop, or sitting box, for the broody should be about twenty inches square, a little more or less will not matter. Some people prefer a wooden floor to the coop, but a wire floor is now generally the practice. The coop must have a movable front. It can be placed in a shed, an open shed is an ideal place, or it can stand in the open, sheltered by a wall or fence, provided the spot selected is a quiet one. Care must be taken in making the nest. Hay is mostly used, or straw well broken up will do, and it should be so arranged that it looks like a nest, not just put in anyhow. The centre should be a little lower than the outside. Where the coop is fitted with a wooden floor it is a good practice to put a layer of earth under the hay or straw nest.

The Eggs.

The broody selected must be a perfectly healthy bird and free from lice. If lice are suspected, she should be dusted with a little sodium fluoride a day or two before she goes into the coop. A few china eggs will now be needed, but if these are not procurable then the real thing can be used. Put these in the nest, and settle the broody into the coop as it is getting dark in an evening. A day or two will suffice to find out whether she is sitting well. If she is at all restless another bird had better be found, especially if the batch of eggs happens to be a valuable one. When satisfied that the broody will do, the eggs should be introduced, the china ones being removed at the same time, this work again being done at dusk. A dozen eggs is about the usual number set. More should not be attempted, especially if they are on the large size. They must be recently laid, of a good shape, and free from blemishes. Thin, or rough shelled eggs should not be used. The broody should be taken off every day for feeding and watering, preferably at the same time each day. Feed her by herself with grain, maize if available. If there is a dust bath handy, so much the better. Whilst she is feeding have a look at the nest, freshen it up, and if she has unfortunately broken an egg, remove all traces of it, and wash the remainder with warm water. It will soon be found when the hen has had sufficient food, and she will be guided quietly back to her nest. She will usually be quite ready to return, and in any case should not be driven or roughly handled. During the first day or two, fifteen minutes is a good time for the bird to be off her nest. Afterwards, if the weather is favourable, she may remain off for as long as half an hour. When several birds are sitting in a row of coops, it is the practice to tether them when they are taken off for feeding. This is done by means of a stake to which is attached a piece of string with a slip knot for passing over the leg of the bird. Fighting will then be prevented amongst them. At about the eight day the eggs should be tested for fertility. Examine these by candle light or pocket torch after dusk when the infertile egg can easily be seen and removed. An infertile egg will look exactly like a new laid one, that is clear. The fertile egg that is containing an embryo chicken will have a dark shadow in the centre. If several broodies have been set at the same time, the eggs from all of them will be tested together, and when infertiles are removed, fertile eggs from two or three nests can be put together and one of the hens be dispensed with, or set on a fresh lot of eggs. Just before the eggs are due to hatch it is well to dust the hen with a good insecticide again, just as a precautionary measure. Do not throw away the infertile eggs which were found on the eight day. They can well be used by the pastry cook or the housewife. A sound reason for testing for infertility is to save time, and also if one is using one's own breeding stock, to be

enabled to find the particular pen of breeders that are at fault and if necessary change the male bird. Hatching eggs laid on the holding should be marked with an identification number of the pen they come from. Hatching will generally begin on the twentieth day, if the eggs were fresh when set. Cold east winds may delay the hatching. Some people will immerse the eggs in water, about 105 degrees, a day before hatching, in the belief that it helps to bring the chicks out cleanly, but it is probably better not to disturb the hen at this stage. Leave her alone until the chicks are all out. If the hatch is likely to be a good one, it is advisable to remove egg shells at dusk during hatching provided the hen is quiet and tame.

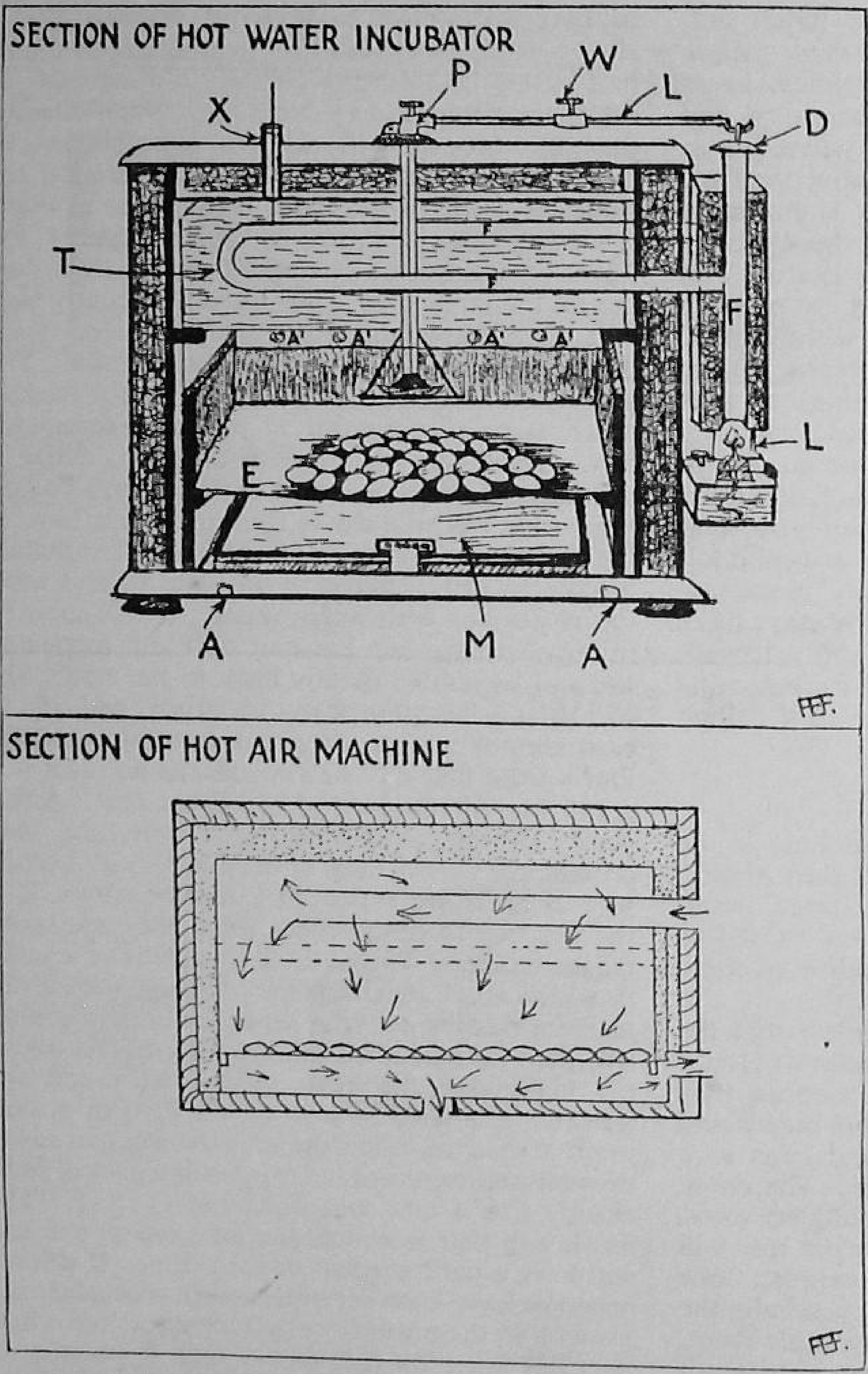


FIG. 13.—When large numbers are being hatched the Incubator is practically indispensable.

When hatching is prolonged, it is sometimes found that chicks stick to the shell and it is possible to assist them by carefully removing it, but in practice it is found that chicks so assisted turn out to be weakly and unthrifty birds.

Incubators.

Artificial incubation is no new thing. It was practised in Egypt 2,000 years ago by means of egg ovens. The hot-water incubator was the first type successfully used in modern poultry farming, and is considered most reliable and capable of the best results. It is more expensive than the hot air machine of a similar size. Other types are the Mammoth, and the Cabinet machine. The number of eggs that can be incubated ranges from fifty eggs in the small unit machines to thousands in the sectional table mammoths and cabinet incubators. A clear idea of the proper working of an incubator is an absolute necessity for anyone embarking on this work.

In the accompanying illustrations, Fig. 13 (top) shows a cross section of a small-unit hot-water machine; Fig. 13 (bottom) shows the same section of a hot-air machine of similar size.

In the hot-water incubator the necessary heat to keep up the temperature of the water in tank T is obtained from the oil-burning lamp L. The heat passes up, and circulates through the flue F, so heating the water. Fresh air passes up through the holes in the floor A and passes above the eggs at A^1. The eggs for incubation are on a movable tray E.

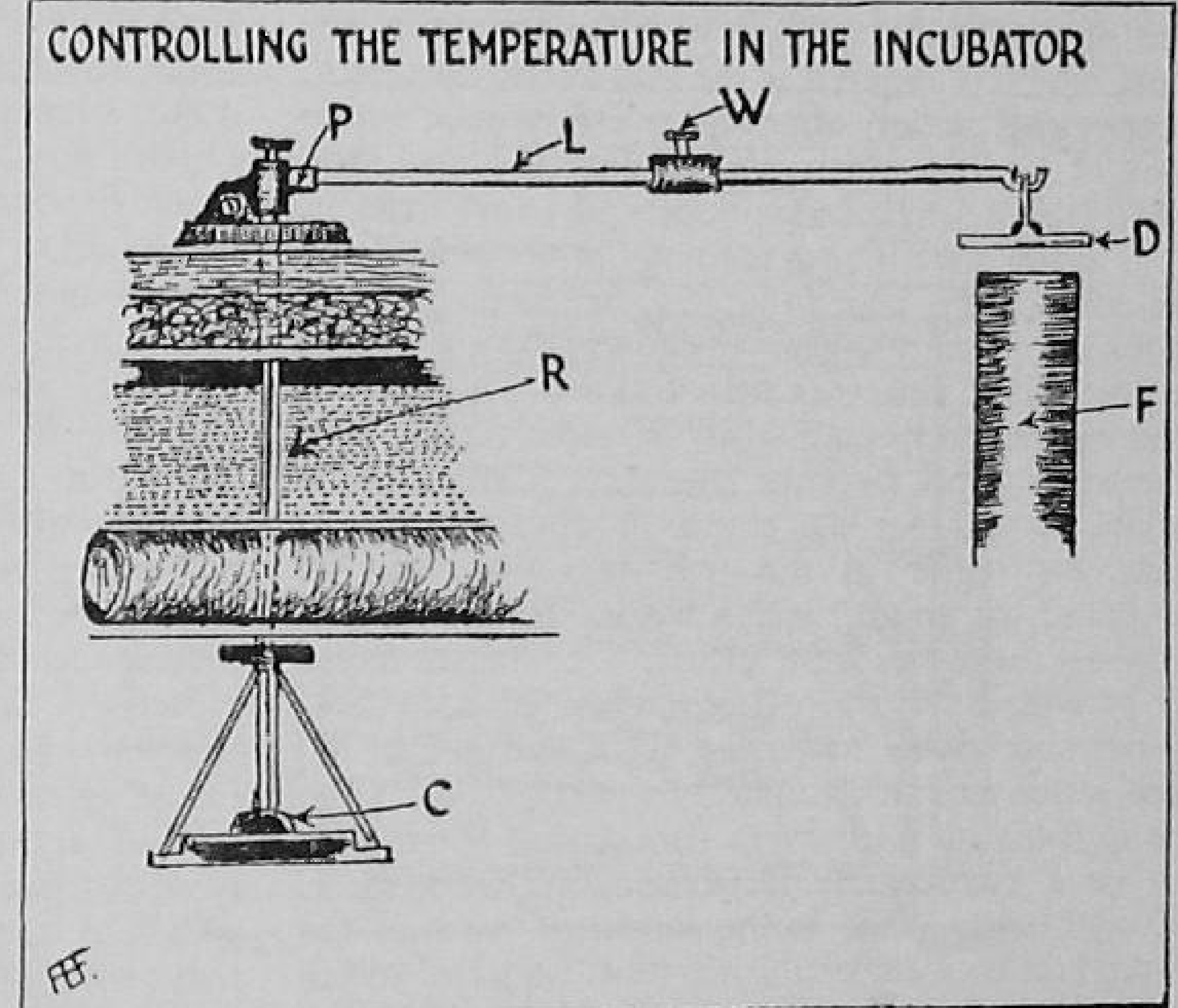
The Details.

In learning the details concerning the running of an incubator, one should get a proper understanding of the *capsule* and how it works. (Fig. 14 (top) for details of this part of the machine.) The regulation of the heat in the egg-chamber is controlled by the *capsule*, which consists of two brass plates soldered together. In it is a small quantity of liquid, modified ether, or something similar, which boils at 99 degrees Fahrenheit. This temperature is a little lower than that required for hatching out eggs successfully. Water boiling at 212 degrees will generate vapour

which, from its powers of expansion, will exert great pressure. For that reason a glass container will sometimes burst if there is no escape for the vapour. When the water is cooled it will take up about the same space as it did before being heated. On the same principle this *capsule* will expand as its contents become heated and vaporize. As the heat becomes less the sides will contract and lie close together.

Adjustments.

Now if Fig. 14 is examined it will be seen that the upper end of the flue F has directly over the top of it a plate damper D, which, if allowed to rest on the top of the flue will stop any heat escaping, and it will all have to pass through the flue into the water tank. If the damper is raised at all, some, or all, of the heat will escape that way. The temperature of the water and of the egg chamber will depend on the amount of heat passing through the flue in the tank. Since the eggs being hatched require a constant temperature, it is essential that the damper should open or close if it varies. Something is wanted in the egg chamber connected with the damper to control it. This is where the *capsule* (C) comes in. Resting on a plate in the egg chamber it supports a rod R which in turn is connected with a lever L at the point P, and from this lever is suspended the damper. Assuming the egg tray has been taken from the machine for inspection, cold air entering will have lowered the temperature, the damper will be resting on the flue and the capsule will be flat. When the egg tray is put back and the drawer gets heated up again, the contents of the *capsule* will boil and the sides will swell out. This will lift the rod a little which will in turn raise the lever and the damper attached to it, allowing heat to escape from the lamp. In starting the machine up, it will be found that the heat may have expanded the *capsule* which in turn has raised the damper, but that the temperature of the egg drawer is not high enough. Here the sliding weight W comes into use. If moved to the right towards the lamp the damper will be closed down on the flue, and more force will be required to raise it. Consequently the temperature will be increased in the water and egg drawer. On the other hand if too much heat is being registered the weight should be moved a little to the left, away from the lamp, so that the damper will open more easily and allow some of the hot air to escape. It will not be found necessary to move the weight very much in adjusting the temperature. When the required temperature is obtained, the weight should be clamped to the lever by means of the screw provided. Having once adjusted the heat in the drawer, it will be found to remain constant through the hatch, not varying more than a degree or two whatever the change in the temperature outside. If, however, it should become necessary to adjust the temperature again, this should be done by moving the weight slightly to



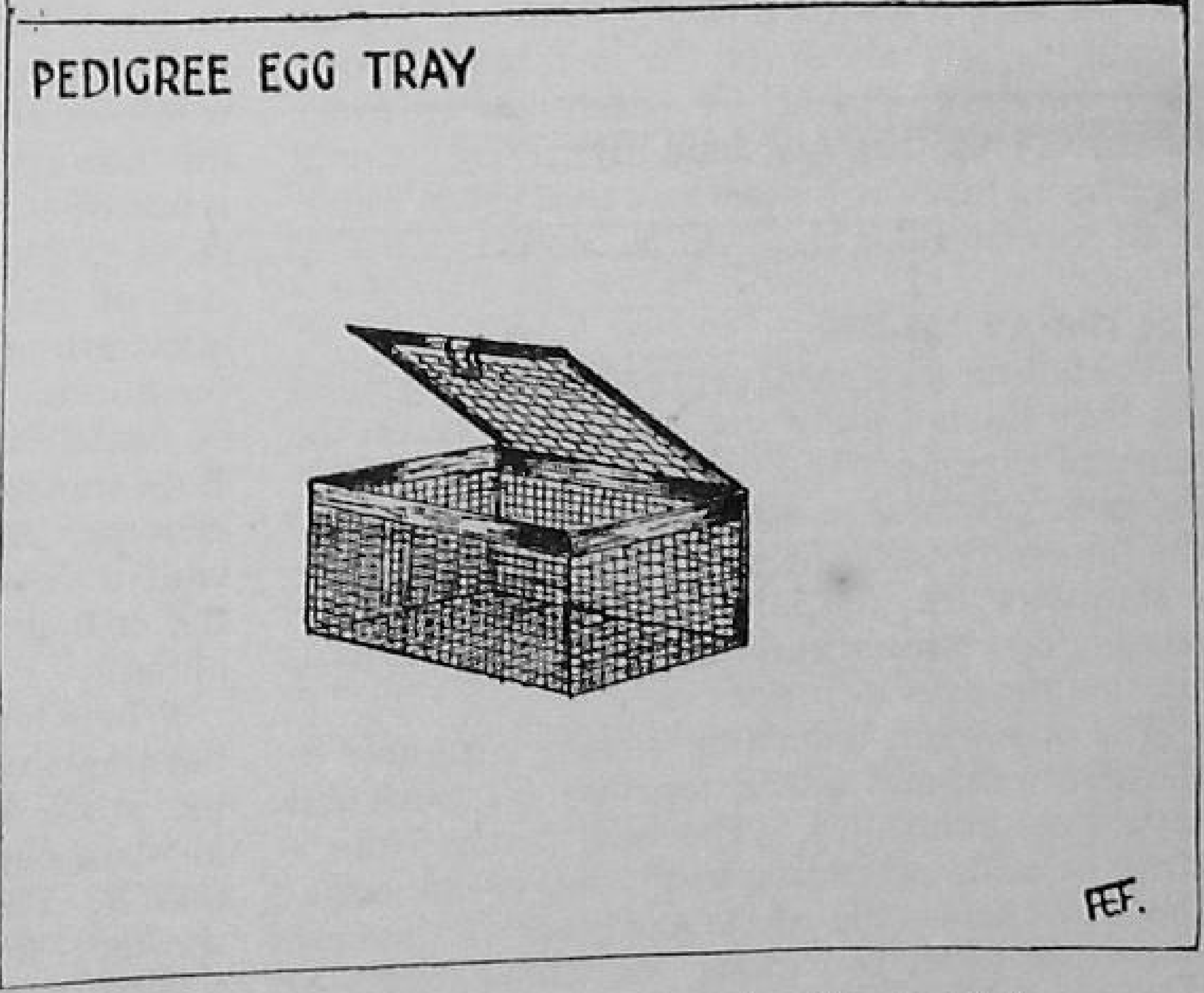


FIG. 14.—*Above.*—A most important part of the machine. *Below.*—Used for keeping track of special eggs during incubation.

right or left as required. When getting a hot-water machine ready for use it must be seen that the tank is filled with warm water. If incubating is going on over a long period a little water will be required to be added to the tank from time to time to replace that lost by evaporation. Filling is done through a tube at X. Hot-water machines are also provided with a tube for emptying the tank which is situated at the side of the incubator. Above this outlet is another overflow tube which should be kept open when filling the tank and only closed when water begins to come from it.

A water tray is provided at the bottom of the machine (M) which should be three-quarters filled with warm water. Inside this tray is placed a perforated zinc tray upside down. A piece of wet canvas or hessian, with the sides tucked into the water is put over the zinc tray. Care must be taken to see that the canvas is always wet and that the water in the tray is replenished as required, or about twice a week. Both tray and canvas must be kept clean. A thermometer is provided for the egg chamber of both hot-water and hot-air machines, the water tank of the hot-water machine requiring a second one. The lamp must be filled every day (unless it happens to be a particularly large one). This work is always better done in the mornings, so that the lamp can be watched. Care must be taken to see that the wick is always properly trimmed. No oil should be left about in the incubator room. Thermometers should be tested before every hatch. This can be done by trying several together in lukewarm water and then in hot water. If all register alike, they will be correct.

The Hot-Air Machine.

The hot-air machine is probably in more general use than the hot-water one. This may be on the score of expense. The working is practically on the same principle in both machines. In place of the hot-water tank the air is heated by the lamp and enters the machine above the egg tray, passing downwards and out through the bottom, heating the eggs as it does so.

The mammoth incubator is really a number of the small machines built up together, with each unit separately controlled. The heat comes from a stove or lamp according to the size of the mammoth and serves the whole machine. In this case hot-water pipes run along the whole length at the top of the incubator, the air warmed by these pipes passing down on to the eggs and out through the bottom.

The cabinet incubator is popular to-day with the hatcheries and with those who do a large business in day-old chicks. Capable of taking many thousands of eggs, this type is very economical in the room required to house it. It is usually run by electricity with good results both for heating, and for fans to give air circulation. In the cabinet, eggs are put on their pointed ends into trays which are arranged in tiers. Turning eggs in a machine of this capacity is not the long job that might be imagined. It is done with an external lever which rocks the groups of trays first at one angle and then at another.

Housing for Incubation.

It is essential to have some special room, or kind of housing, for incubation. Where only a small machine is being used, it can be housed quite successfully in the poultryman's home. Cellars too have proved good incubator rooms. Brick or stone buildings have often given better results than wooden erections. An incubator should not be housed in a building that gets very warm, so choose a place facing north if possible, and if the building be partly underground, so much the better. If a wooden incubator room is to be built it should have double walls with an air space between. To help in keeping the temperature constant the inner wall should be made of some cellular material for preference, a ceiling being made of the same material. Some people have the space between the walls packed with straw. The floor should be of rammed earth, or perhaps, to keep out vermin, cement would be better, laid to a depth of about twelve inches. A wooden floor, unless well laid, may encourage vibration to the detriment of the hatching eggs. Windows should be on the north side, and also on the east if possible, well up above the incubator. If shutters for the windows are provided, they will be useful when the time comes to test the eggs. There are various types of ventilation, which is a most important point in planning an incubator room. Probably one of the most satisfactory systems is where inlets are provided at floor level on both sides of the house. The inlet in the outer wall should not be exactly opposite that made in the inner wall. Both should be controllable by slides. The outlet is in the ridge of the building and this is provided with a cover to prevent a down draught. In the ceiling of the room there is a controllable outlet.

Where large size incubators heated from a coal-burning stove are being used, it is usual to house the stove in a small annexe attached to the incubator house, and made just large enough to take it. The heating pipes are then made to run through the walls from this annexe to the incubator-room proper.

In building an incubator house space should be provided for a table which will be required for holding the egg trays.

In the incubator room humidity thermometers are very useful, if not a necessity, for recording the moisture in the air. An ordinary thermometer for recording the temperature of the room should also be hung up. The room temperature should be between 60 and 70 degrees F., and the humidity between 60 and 70 per cent. If the air is too dry, the floor should be sluiced with water. Peat moss is sometimes kept under the incubators, in trays

on the floor, and this is kept soaked with water when necessary. Incubators should not be placed close to the walls.

Incubating the Eggs.

Choosing Eggs.

All eggs for incubation should be marked with the number of the pen from which they are collected, and the date. Where trap nesting is done the number of the hen should also be marked on the egg. If a number of eggs in a hatch turn out to be faulty it will then be easy to trace the birds, or pen responsible.

Hatching eggs should be carefully chosen. They must be clean; small eggs should be rejected, only those scaling 2 ozs. or a little over, should be used. Examine the shells, discarding all thin and rough shelled, or misshapen ones. The fresher the eggs the better, and it is wise not to use those over twelve days old. When collecting eggs for incubation from the breeding pens, store them carefully in a building in which the temperature does not vary a great deal. It should be between 45 and 50 degrees Fahrenheit. They can be laid out on a shelf or in boxes, and should be covered but not to the extent that no air can get to them. It is advisable also to turn them each day if possible. If not marked in any other way, mark each egg with a cross in pencil, to make sure it is always properly turned. After one turning all crosses will be showing, after the next turn no crosses will appear. In the very cold weather, eggs should be collected from the nests several times a day to prevent freezing.

Turning the Eggs.

When the time arrives to incubate, the temperature of the machine should be standing steadily at 103 to 104 degrees. See that everything is in order. The eggs can then be placed on the tray, the tray being removed from the machine for the purpose. Lay the eggs on their sides and do not pack too tightly or turning will not be satisfactorily done. When the tray is returned to the machine, do not close the door at once but allow the eggs to warm up gradually. The door may be closed after an hour or a couple of hours. In the hot-air machine, the thermometer should now be hanging just above the eggs. Begin turning the eggs on the third morning. It used to be the rule to turn eggs twice, and cool them once a day by removing the egg-tray from the machine for about a quarter of an hour. This custom has been altered somewhat in recent years and poultry farmers now turn the eggs three or four times a day at regular intervals, but do not cool them at all. The object of turning the eggs is to prevent the embryo sticking to the shell membrane. A broody hen sitting on eggs moves them about herself. Turning by hand three or four times a day would be a lengthy business if many eggs were being dealt with, and to save time most machines are now fitted with a mechanical turner. These are satisfactory in use if carefully handled. On some establishments eggs are tested for fertility on the sixth or seventh day, and are tested again for addled eggs and broken yolks on the eighteenth day, but the latter test is really not necessary. Another practice is to test on the twelfth day only, removing infertiles and such addled eggs, and those with broken yolks, as are easily recognizable. Eggs can be readily tested with an electric torch which is run under the bottom of the egg tray. Unless the windows in the incubation room can be darkened, the test will have to be made after dusk. If there is any doubt about the infertile eggs, keep a new laid egg handy when testing is taking place, and make a comparison. An addled egg will look cloudy and have a black spot adhering to the shell. When the yolk is broken a blood red line will be seen in the egg. Remove all the rejected eggs from the tray, disposing of the addled eggs and those with broken yolks by burning, but putting aside the infertile eggs for use in the kitchen.

The Nursery.

Turning should stop on the eighteenth or nineteenth day, and it is a good practice not to open up the machine again until after the hatch is finished. Hot-air machines are provided with a chick nursery immediately under the egg-tray, the idea being that as the chicks hatch out they come forward towards the light, and drop into the nursery tray. It has been found in practice, however, that it is easy to get the chicks chilled if they are in this compartment very long, as the temperature is often several degrees lower than that of the egg-tray where they hatched out. Access to the nursery therefore is closed by bringing the egg-tray forward a little. The nursery is not used at all unless the hatch happens to be an extraordinarily good one, and there is overcrowding on the egg-tray. It may then be advisable to use it when the hatch is three parts complete. In hot-water machines the chick nursery is in some cases situated at the top of the incubator. In that case the opening up of the machine for the removal of the chicks if there is overcrowding, cannot be avoided, and it should be done as expeditiously as possible. The only chicks that should be kept for the brooder are the strong healthy-looking ones that have hatched without any help. The custom that prevails in some quarters of helping weakly chicks out of their shells, whilst it may swell the numbers and increase the percentage hatched, is not to be recommended, for the chicks so helped rarely pay for the trouble taken, seldom living for more than a week or two, and always being a potential menace to the rest of the chicks.

When incubating in very dry weather, particularly when an east wind persists, it is sometimes advisable to put a bucket of hot

water under the machine twice a day during the last week.

Transferring Chickens.

In transferring chickens from the incubator to the brooder house, they should be taken in a covered box (one lined with flannel that has been warmed if possible). Care must be taken to prevent them getting chilled whilst being removed from one house to another. It often happens that a special lot of eggs has been incubated with others and it is necessary to keep trace of the chicks that hatch from these. Maybe they are intended to introduce a change of blood into the stock. These special eggs should be put into muslin bags, or wire cages on the eighteenth day. When they hatch out they are toe-punched so as readily to be identified throughout their lives. The pedigree breeder in the course of his work has to do this in a large way, not only hatching eggs from his special hens separately, but also keeping the eggs from one bird apart from another. As soon as the hatch is over and the chicks have been removed to the brooders, the incubator should be thoroughly cleaned for the next batch of eggs. All remaining dead chicks, and shells, should be removed and burned. The hessian mats covering the egg trays and nursery tray must be thoroughly scraped, brushed, and cleaned in boiling water to which has been added a reliable disinfectant. The trays should be removed and treated in the same way, and the inside of the incubator well brushed out.

Routine.

Every care should be taken to see that this work is properly done, and should, as a matter of routine, be done after every hatch. All through the hatch, it is useful to keep records. This is essential if a good deal of incubation is taking place. A hatch may turn out disappointing and in looking for the cause of the trouble it is well to have in front of one a record of:—

(1) The daily temperature of the egg drawer and the incubator room itself.
(2) The daily humidity of the incubator room.
(3) Number of eggs set.
(4) When the testing was done, and the number of infertiles, broken yolks, addled eggs and dead in shell, removed.
(5) Number of chicks hatched.
(6) Number of dead in shell remaining.

All these points should be taken into account and examined if the hatch has proved a bad one. Incubator temperature may have been too high, or too low, or may have fluctuated. Humidity may have been at fault, moisture too low. Eggs may not have been fresh, or have been badly stored. Infertiles may be traced to one particular pen and the male bird found at fault. Addled and dead in shell may come from weak germs and the hens in question be the cause of the trouble. Broken yolks may be the result of rough handling of the eggs, or vibration in the incubator room. The keeping of records will probably help to put a finger on the cause of the trouble.

THE GROWING CHICK

Brooding—natural and artificial methods. The broody hen and its care. Different makes of brooders and their management. The after care of growing chicks. Various ways of housing them and keeping them healthy.

Rearing.

REARING is one of the most important, if not the most important part of the poultry farmer's work. The rearing season, which comes in the spring months of the year, finds the farmer at his busiest, giving constant attention to his young stock all through the day, and ready to turn out at any time of the night if a change in weather conditions necessitates an eye to the brooders. It has been said—and with much truth—that the future laying stock is greatly influenced by the way it is being reared. The rearing period really runs from the day the chick is hatched right through to the time it goes into its laying quarters, or in the case of the table bird, up to the time it goes into the fattening coops. The first part of the rearing is known as the brooding period—i.e., the time during which the young chick must be provided with some warmth, either naturally from the mother hen, or artificially from oil-burning hovers, coal-burning stoves, hot water pipes and the like. The period when heat is required will change with the time of the year. Eight weeks is the usual time, with six weeks a sufficient term in the late spring, when the weather is warmer. The second part of the rearing, known sometimes as the " carry on " period, is after the chicks leave the brooders, or the broody hen, and are transferred to grow on in colony houses, either on range or intensively.

The Brooding Period.

It is the brooding period that will be dealt with here. Only people in a small way, domestic poultry keepers and the like, use the natural method of brooding by the broody hen. Not that there is anything wrong about it. If broody hens could be obtained in sufficient numbers and at regular intervals, the natural method of brooding would probably be more in use than it is. This supply of broodies when required, has however proved the bugbear on large holdings where much rearing has to be done, though, as stated earlier, one breeder in a big way of business did rear with broody hens up till quite recent times. The labour entailed in natural rearing is probably higher than with artificial rearing, though the latter system requires more experience and greater skill.

In deciding on the method of brooding to use, it must be remembered that if artificial methods of incubation have been practised, then artificial methods of brooding should follow.

In the natural method, as stated above, the broody hen will provide all the warmth required by the chicks. There is no risk of fire, as in the case of artificial rearing, and it is still the best way for the novice, for the broody hen will often succeed where the rearer himself fails.

The Rearing Coop.

The rearing coop should be a little larger than a sitting box, about two feet square. It should slope from front to back, say about two feet high in front and 18 inches at the back. Unlike the sitting box, the rearing coop must have a wooden floor to facilitate cleaning and to guard against vermin and dampness. This coop is also slatted at the front, the centre slat being removable; and it should be provided with a hinged shutter fitted with air holes at the top, so that the front can be closed at night. The hen can take up to a dozen chicks if she is a good sized bird. If she has had only a moderate hatch, say six chicks, and another broody has had almost the same number, then both hatches of chicks can be put together under one hen, but do not let her have more than 12 day-olds. Some breeders will allow the hen out with the chicks after a day or two, but the general, and probably the best, practice is to keep her cooped, moving the coop daily a short way to fresh ground. The grass where these chicks are being reared must be kept short. Where it is allowed to get long, it will often result in the chicks getting wet, with the probability of chills and casualties. When the hen is allowed out with the chicks, she will range so extensively at times that the chicks will get overtired and suffer accordingly. Day-old chicks will not require much to eat for a day or so, a little but often is a good plan. Stale bread-crumbs, or a little pin-head oatmeal, moistened in milk will be an excellent feed, and this at first should be given on a board, in or close to the coop. After a day or two they can be fed in front of the coop where the hen can see them. The chicks can then be put on to a mash made up by the farmer himself. This is best fed in a crumbly moist state. In addition a little corn can be given if desired (see under feeding). The hen must not be neglected and she should have a suitable wet or dry mash, with a feed of corn if preferred. Care must be taken to see that the food for the hen is so arranged that the chicks do not get access to it. Clean water must always be available for hen and chicks, and grit must be supplied, that for the chicks being very small and of a kind specially sold for the purpose. Their grit may be sprinkled in front of the coop. A wire surround should be used so that the chicks cannot stray, and it should not be removed until they are turned a month old. Just when the hen should be taken away from the chicks will be a matter for observation. She will begin to tire of them and it will be found they are sleeping away from her. This may be when they are between six and ten weeks old, according to the weather. When this time comes the hen may be put back to her laying quarters and the

chicks left in the coop for a time, before being transferred to the rearing house, or they may be taken there at once.

Artificial Methods.

There are quite a lot of artificial methods and ways of brooding. The small unit brooder, a favourite with many, consists of an oil-burning hover fitted with canopy and capable of brooding from 50 to 150 chicks. This is usually accommodated in a small house to take one brooder. There is much to commend these small unit rearers. The house itself, usually about eight feet square, should be sectional so that it can readily be taken down and erected on a fresh site after the rearing season is finished. This change of rearing ground, whenever possible, is of great benefit to the chicks. It is often the means of checking an outbreak of disease which usually follows the use of the same rearing ground over an extended period. With the object of avoiding the use of tainted ground, where the removal of the house is not practicable, or a spare rearing ground is not available, it is now customary to have what is termed a "sun parlour" attached to these small unit houses. This sun parlour is erected in front of the house, and is almost two feet high, with boarded sides, wire framed top, wooden floor, wire floor with dropping boards underneath. The chicks have the advantage of using the sun parlour when the weather is suitable, and if the houses are properly placed, of getting the maximum amount of sun at a time when it is very beneficial to them. Several of these hovers can be used in a large house with suitable surrounds to each hover to keep away floor draughts.

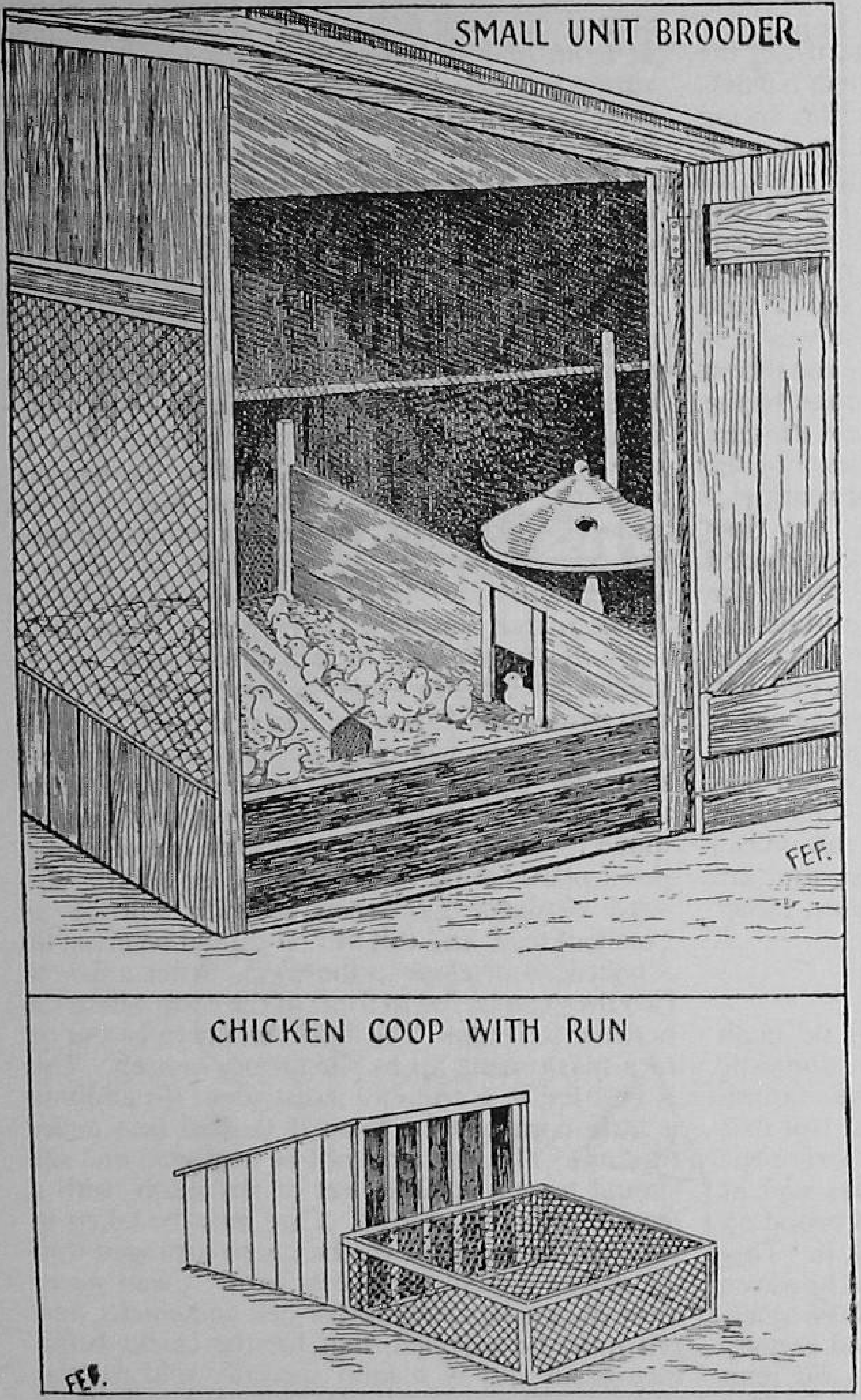


FIG. 15.—*Above.*—Capacity about 100–150 chicks.
Below.—For mother hen with her chicks.

Large Stoves.

Then there are the large stoves heated by anthracite, and which will brood up to 300 to 500 chicks. These cannot be used in movable houses. Fuel other than anthracite cobbles should not be used in them. For some reason this particular kind of heating apparatus is not so popular as was once the case. Probably smaller units are preferred. At the same time the writer remembers rearing some good chicks with these large anthracite stoves, with very little trouble, and they proved excellent for providing a steady temperature.

Brooder Used Intensively.

A very satisfactory type of brooder used intensively is made to stand on legs well up from the ground, with another brooder above it. This not only conserves space, but the additional heat from the extra brooders thus accommodated helps to keep a higher room temperature. These brooders, which have runs with wire floors attached, and dropping boards under the floors, are heated either with oil-burning lamps, or by electricity. Brooders electrically heated have been proved a great success in actual practice. They are not the anxiety those with a lot of oil-burning lamps can be, with the danger of fire;

and except for the possible failure of current long enough to cause the chicks to be chilled, no trouble need be anticipated with them.

Brooders used in intensive rearing sometimes obtain their heat from hot-water pipes which run along the whole range of the building and over which is fixed the canopy which can be lowered or raised as the occasion demands. Each unit will usually be wired off and fitted with a boarded surround some 18 inches or two feet from the ground to prevent floor draughts.

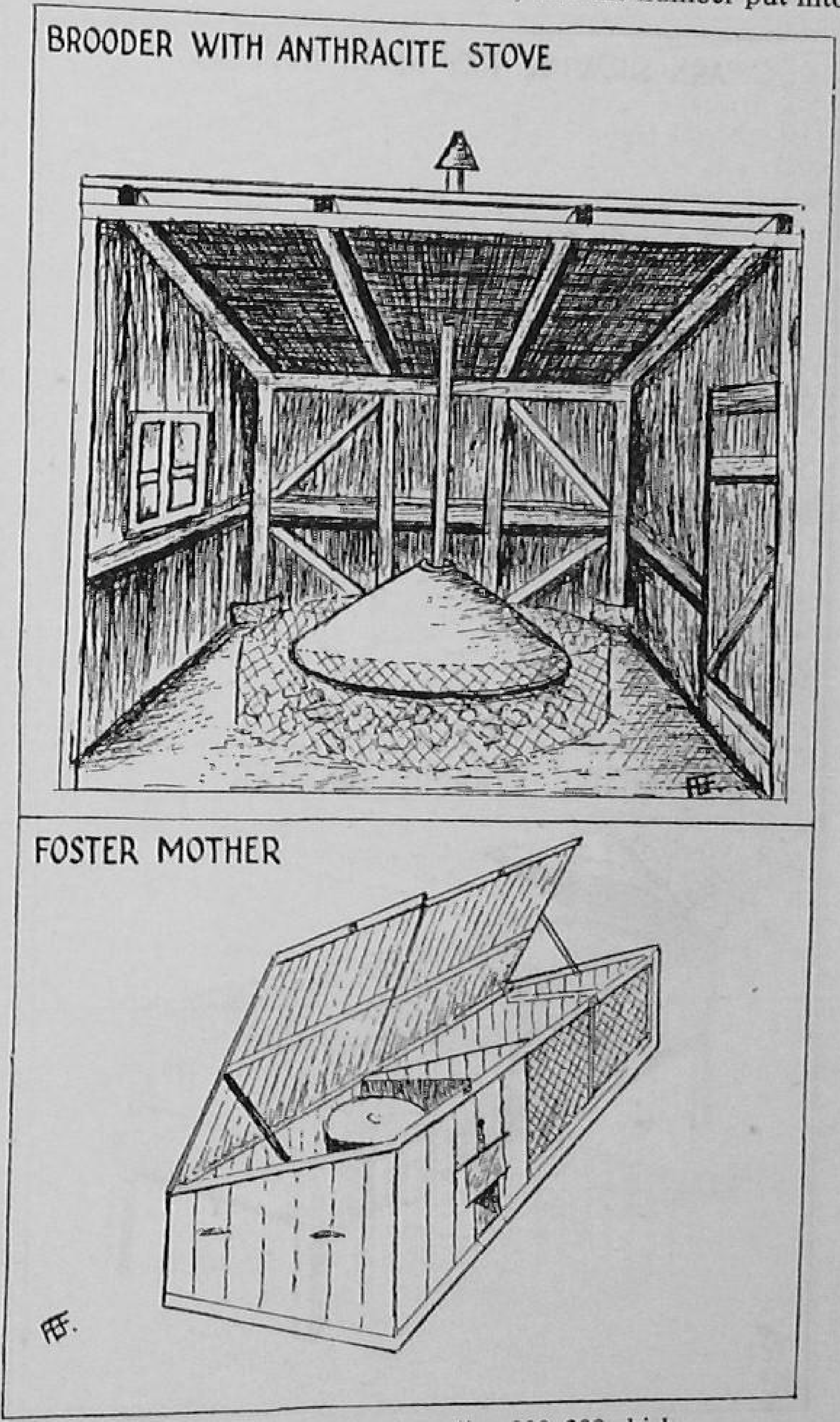


FIG. 16.—*Above*.For—brooding 200–300 chicks. *Below*.—Still a favourite.

Battery System of Brooding.

Some years ago the battery system of brooding was introduced from America. The cages on this system are built up in tiers, and obtain their heat, which can be regulated, from hot water pipes connected with an anthracite stove, usually accommodated in a small erection attached to the battery house. This system claimed a lot of adherents, and many good chicks have been reared in them. They are not so much in favour in some quarters now.

Some mention of the outdoor type of brooder, or foster mother as it is called, should be made. Used extensively some years ago, and perhaps looked upon as old-fashioned now, it gave very satisfactory results, and can still be used with advantage where only small numbers are required. With this type of brooder it is often not advisable to attempt to rear the number of chicks recommended by the maker, or overcrowding, a great fault in chick rearing, may be the result. These foster mothers usually have two or three compartments. The door between the heated chamber and scratching compartment should be kept open so that the chicks can easily find their way in and out. The foster mothers must be put on level ground, and are easily movable to a fresh site. If many are in use, there is the disadvantage of having to do all the work required outside, such as seeing to the lamp, and cleaning out, in any kind of weather.

The Fireless Brooder.

The fireless brooder is not in use on commercial holdings but satisfactory rearing can be done with it in a small way. It consists of a box with a lid, about 18 inches square and 12 inches deep. About six inches from the floor a light wooden frame rests on wooden corner supports. The frame is covered with some light material or muslin on which rests a soft cushion. When the chicks are standing this cushion just reaches their backs. The heat generated by the chicks is conserved by the cushion. A nest of hay is provided for the chicks, and the number put into the brooder, about a dozen, have room to move around. Care must be taken to see that the chicks do not get overheated, and they must be well ventilated. Ventilation holes are provided at the top and bottom of the box. An opening provides for the entry and exit of the chicks. The writer has seen some excellent chicks reared on this system, but one must be prepared to spend a

lot of time with them, teaching them the way in and out of the box, to obtain good results.

Management.

The management necessary for brooding chicks will be similar in many respects for all types of brooders. Take the question of heat for instance.

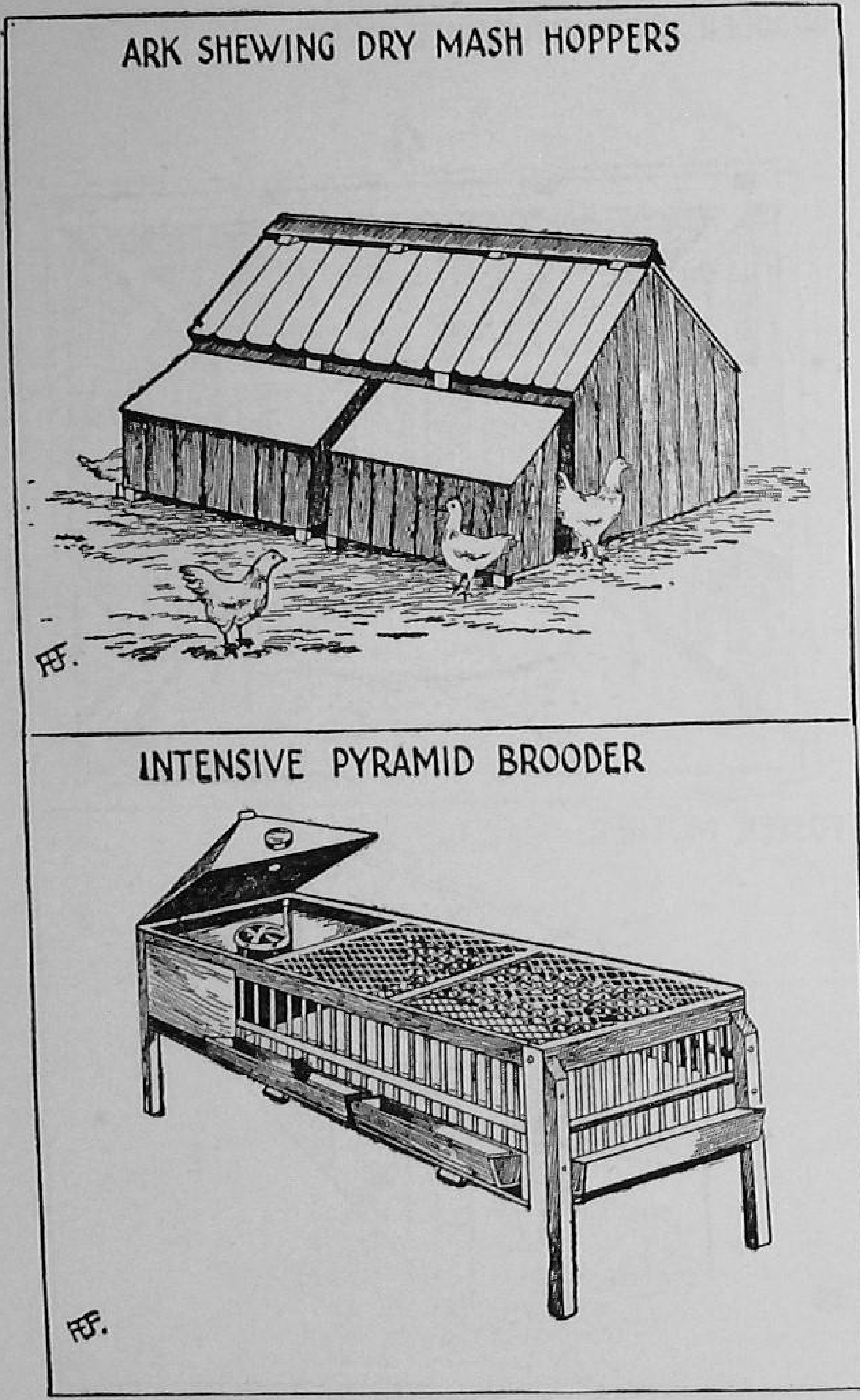


FIG. 17.—*Above.*—Hoppers need only be filled once or twice a week. *Below.*—This type of brooder gives excellent results.

The day-olds will have been brought from an incubator where they may have been confined in a temperature of about 101 or 102 degrees. If they are to be kept free from chilling, the temperature of the brooder must approximate to what they had in the incubator. Lamps or other hatching appliances are therefore adjusted so that the temperature of the brooder will stand at 90 degrees before the chicks are brought in. It will be found when they are settled down that their body heat has brought the temperature up to 100 degrees. It must not be allowed to go higher than this, for excessive heat as well as underheating can result in chills. The temperature is then lowered at the rate of about 5 degrees a week. Some brooders have a thermometer provided upon which the rearer will rely. Other rearers prefer not to use a thermometer at all, depending on the chicks themselves to let them know when there is too much or too little heat. In the former case, they will find the chicks getting away from the lamp; in the latter case, they will be crowding towards it, and showing signs of distress. Oil lamps should always be cleaned and trimmed and any adjustments made in the morning. The temperature should never be altered at night unless this is absolutely necessary, and then the brooders should not be left until the lamps have been watched for half an hour. The flame will sometimes draw up after it has been adjusted.

Attention.

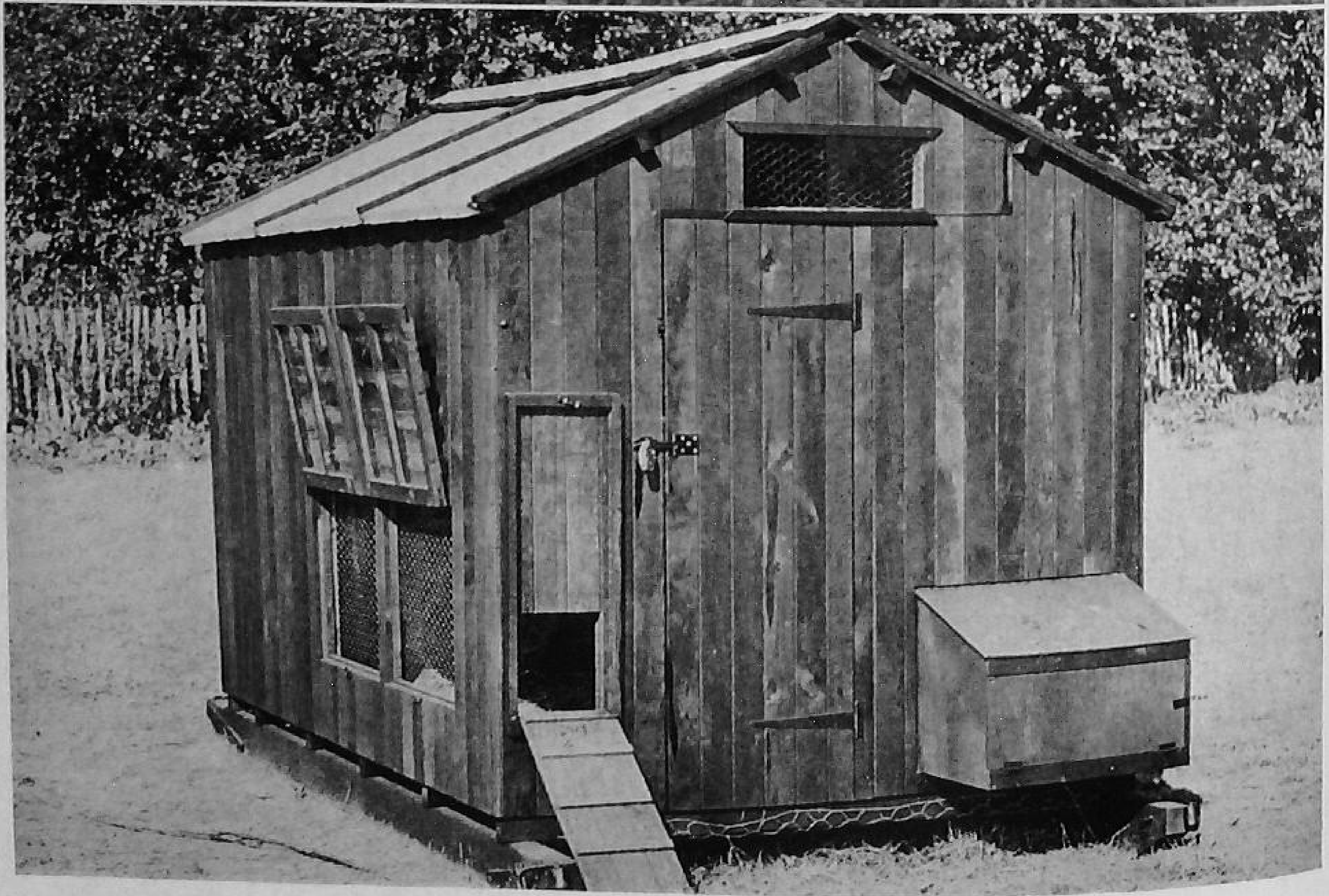
In all types of brooders the chicks must be carefully attended to for the first few days. They should be kept close to the heat the first day and not fed, allowing them to run out if they will, but returning them soon afterwards. They must then be taught to come out and feed and return to the heat as necessary. The food and water should be kept close up to the brooder at first, gradually moving it a little further away each day. As with naturally-reared chicks, their first meals should be on a board, a little and often, to which they should be encouraged to come by a slight tapping on the board. After the first day or two the regular meals can be started, dry mash always before them if preferred, or a crumbly mash four times a day at first, and then reduced to three meals. (Rations for brooder chicks will be found under "feeding.")

All the different types of brooders must be kept scrupulously clean, together with the feeding troughs and water fountains; the dropping boards, if used, must be attended to; and the overcrowding of chicks must be carefully avoided. A check at this important stage of the

BRITISH BREEDS OF POULTRY

RHODE ISLAND RED

Courtesy: Nackington Farms



Above : A PICTURE OF HEALTH : LIGHT SUSSEX POULTRY
Courtesy: Nackington Farm

Below : PORTABLE FREERANGE (HANNAFORD) HOUSE
Farmer & Stockbreeder Photograph. Courtesy: Nackington Farms

chick's life must be avoided at all costs, and it is essential to prevent the chicks being in a draught which will lead to a chill. For this reason where floor brooding is practised, it is the rule to have a wooden surround to the hover for a few days to prevent the chicks straying too far. Even after this, some sort of protection should be provided for older birds if floor draught is suspected.

The sexes of the light breeds should be separated by the time they are due to leave the brooders. The cockerels will be easily identified by the development of the comb.

REARING (THE GROWING ON PERIOD)

The Term Rearing.

The term rearing here refers to that period between the end of the brooding period, and the time when the pullets are matured and about to be transferred to their laying quarters, or in the case of table birds, when they are gathered up to go into the fattening cages. The age at which chicks will leave the brooders depends upon the time of the year and the weather. If the weather is favourable, and there are prospects of its continuing to be so, and if the chicks have feathered well, then it is quite safe to do away with heat when they are six weeks old. Early in the year it is better to leave them in the brooders until they are eight weeks old, or even nine weeks if the weather happens to be very severe. Towards the end of the brooding the chicks will be gradually broken to the new conditions they are to experience, the lamps will be much lower than earlier on in the brooding, and in the last week they will be out all day and only lighted for the night. A good indication that the birds are ready to dispense with heat altogether is when you find them at night sleeping away from the hover. The cooling off must be done gradually, however, and if the lamp is not used, it is unwise to remove it from the brooder. Left in position, the chicks from habit will lie around as they did when it was alight. If taken away they will crowd into the corners of the brooder and some will get crushed.

If the birds are going to be reared on range—and it is the general opinion that certainly at some time during the rearing period the birds should be out on the ground—then the Sussex Night Ark is one of the best carry on houses for the purpose. These arks are about 6 ft. long and 3 ft. deep, fitted with a slatted floor with boards underneath to collect the manure. About forty chicks can be comfortably accommodated in an ark of this size from the age of 8 to 16 weeks, after which the number should be reduced. If it is intended to wire in an area for the ark, then one about 90 square feet is a useful range. A good many farmers do not wire in the arks at all, saying that if they are placed in a field a fair distance apart, and if water and food hoppers are kept close to the ark, there is not much risk of the chickens all crowding into one or two arks. If this should occur when the chicks are first put out, steps must be taken at once to sort them out, as trouble will ensue if they are left overcrowded even for one night so that they get into a sweated

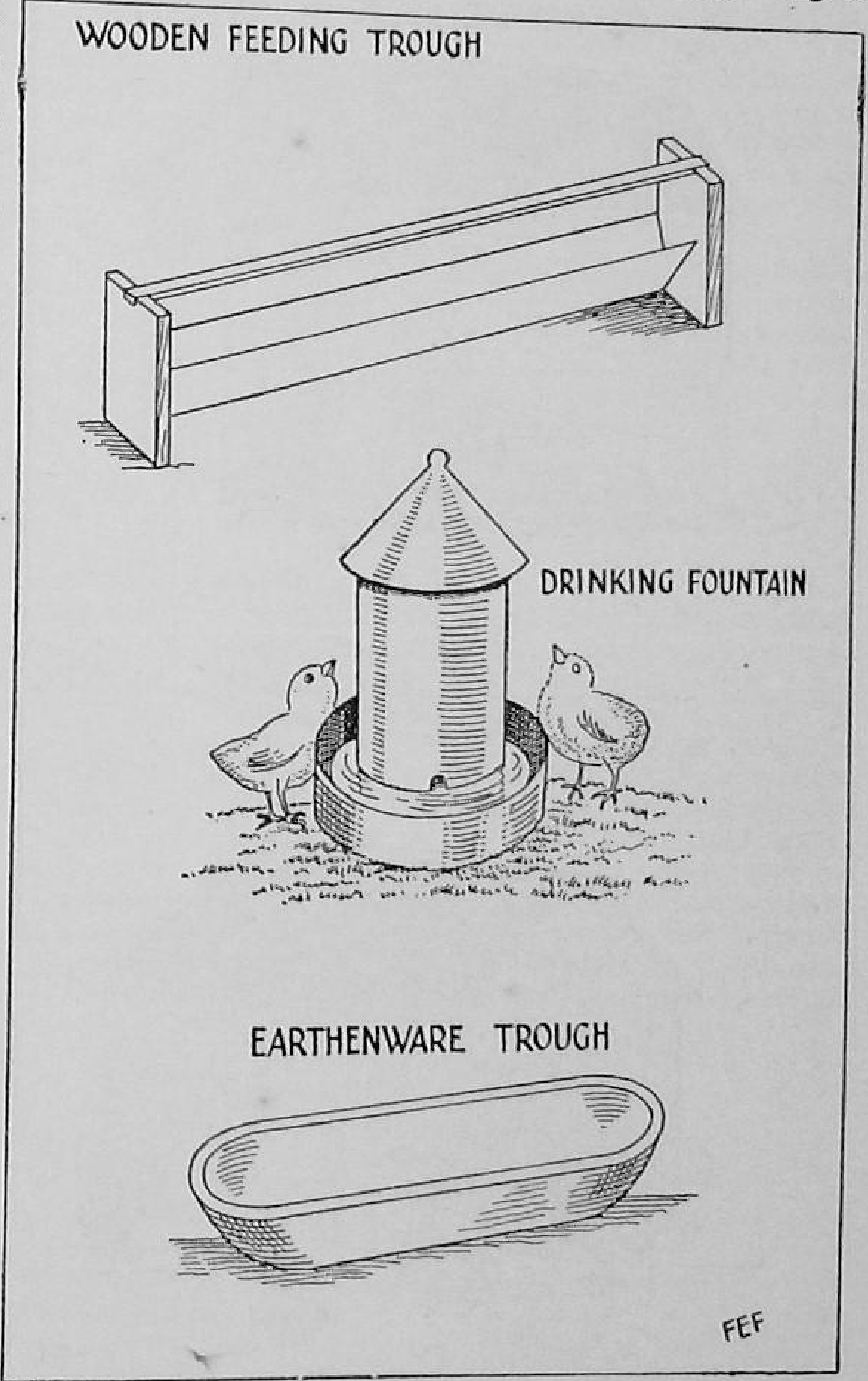


FIG. 18.

condition. If the chicks are comfortably housed in arks, and if they have a proper ridge and cave ventilation, then trouble from colds even in the most severe weather is not likely to occur. The Sussex Night Ark (see illustrations) has an opening in the front, which can be closed either with a wooden or wire slide. It also has a slide door in the roof. This is very necessary when one is wanting to catch and remove a bird. On some general farms the ark is not fitted with a dropping board, the droppings being allowed to go through the slatted floor and on to the ground. In very cold weather it is sometimes advisable to spread sacks over the slatted floor of the arks when the chicks are first put into them. It is also advisable to put a temporary surround of wire netting round the arks for a couple of days until the birds are used to their new surroundings.

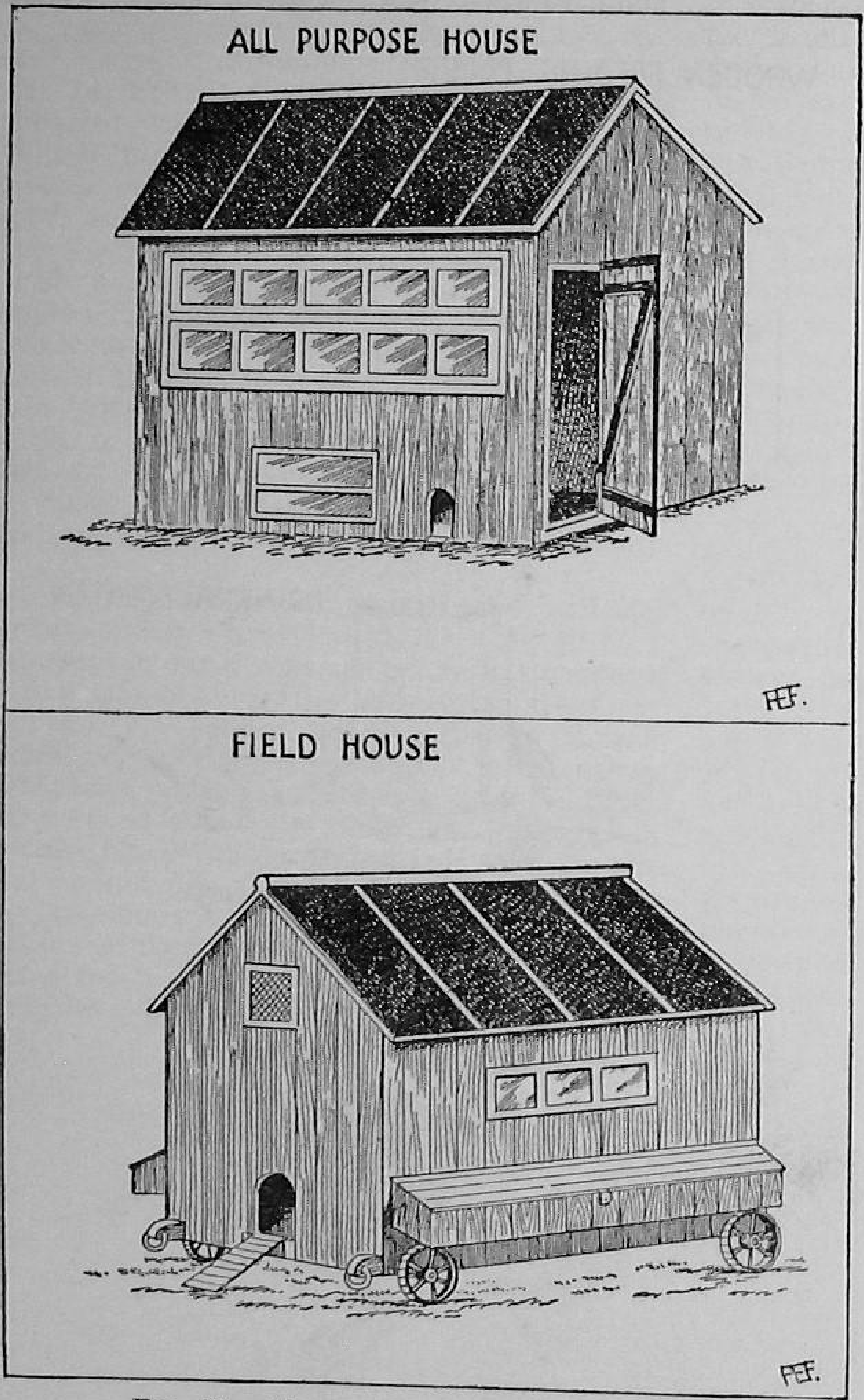


FIG. 19.—*Above.*—Useful if Capital is limited.
Below.—A good house for the stubble.

In dealing with laying hens we have already seen how a fold can be employed with advantage under certain circumstances. It is also possible to use the fold for *rearing*. A drawback is the restricted opportunity for ranging. It must be said, however, that some very good birds are reared in these folds.

There is an all-purpose type of house which is very useful where economy is essential. Chicks can be reared there from day old and eventually perches can be put into the house for the use of the birds as laying stock, or it can be further used as a breeding pen. This house can be moved frequently with little trouble (see illustration).

The Rearing Ground.

The rearing ground should if possible be provided with some kind of protection from the sun and from inclement weather, for the chickens can suffer from either. In the absence of trees, hedge or wall, protection from the sun may be difficult and the birds will have to shelter in the house, but windbreaks made of wattled hurdles covered with sacking or straw, fixed up at each end of the ark or house will take the sting out of the wind. Two parallel hurdles with a third over the top will give some shelter from the sun also.

Where birds are out on range at an appreciable distance from the central buildings of the holding, dry-mash feeding will be a saving of much labour. Dry-mash hoppers of a useful type can be fixed at each end of, or behind, the night ark. The top of the hopper is carried forward to fit against the side of the ark, affording cover for the chicks in wet weather and keeping the mash dry. These hoppers have, in front of the food trough, a shallow trough, which collects any food thrown out by the birds and so saves waste. Care must be taken to see that the hoppers are closed at night or heavy toll of the food will be taken by rats or wild birds. Galvanized hoppers are better than wooden ones, from this point of view, if they can be obtained.

The Growing Stock.

Beyond ordinary routine work, it should not be

necessary to interfere with the growing stock during rearing, unless one has pure heavy breeds. In that case the separation of the sexes will be necessary as soon as it is possible. If light breeds are kept this will have been done before the chicks went to the arks, but it cannot be done with complete accuracy in the case of heavy breeds so early as that. To leave the sexes mixed leads to bullying by the cockerels. In the light breeds the cockerels will start to develop combs and wattles very soon. The heavy breed cockerels feather up more slowly than the pullets, having bare patches on the back at times. The pullets get their tails quicker, and their legs are usually finer than those of the cockerels. The latter do not redden up until later. The best guide is the feathering, and it is safer to wait until the feathers have grown. Then examine the birds carefully, look at the hackle feathers and the saddle. Do not be misled by the baby feathers. It is new ones which are coming that are required for identification. The feathers that are long and pointed denote a cockerel, whilst rounded, or oval shaped feathers denote a pullet.

Passengers.

After the separation of the sexes it is well to go over the pullets and remove the unthrifty ones, i.e. those not doing well. These passengers are best disposed of at all stages of their growth, for unless they are going to come into lay at the proper time, they will be a liability. By far the greater part of the receipts from a poultry holding (excluding the table plant) comes from egg production.

Whilst a grass run is excellent for the growing pullets, care must be taken to see that they do not run in long grass. When it is wet it is likely to give them colds, which might quite easily lead to worse trouble.

Intensive Chicks.

After chickens have been brooded in confinement, it is possible to carry them on in battery brooders, or in houses with wire floors. On this system especial care must be taken in management and feeding. The ration must be a complete one for the purpose. Where the birds are floor reared, sun parlours, or balconies fitted with wire floors are attached to the side of the house where the birds can get the maximum of sunlight. They have the advantage over the battery reared bird, in that they get more exercise. Chicks using the sun parlours get all the sunlight direct, without coming into contact with contaminated soil. With the intensive chicks, plenty of hopper space must be provided, to keep the birds busy, and help to prevent a possible outbreak of cannibalism.

Although keeping chicks on intensive lines has many advantages, especially if it is suspected that the land is contaminated in any way, it must be remembered, as stated above, that every care must be taken in management and feeding. If the poultry keeper has brooded his chicks and successfully reared them on range, he would be advised to continue on the same system if possible.

The End of the Rearing Season.

With the end of the rearing season, many appliances, from the incubator down to the small rearing houses—with their water fountains and feeding troughs—will be finished with for the remainder of the year. Everything should be carefully looked over, and thoroughly cleaned and disinfected. Any repairs required to be done, or any renewals that are necessary, should receive attention at once. This will not only prolong the life of the appliances, but a lot of trouble will be saved later on. Small things should be stored where they can be readily got at. If left lying about they soon deteriorate or probably get lost.

THE LAYING BIRD

Housing the layer, preparing the laying quarters. Lighting for the purpose of increasing production. Finding the best layers . . . by means of the trap nest—and by other methods. How to cull the birds. Choosing birds for future breeding stock.

Precocity.

THOUGH the light breed pullets will have been hatched a month later than those of the heavy breeds, if the hatching for both types has been done at the proper time, then one should look for laying to start about October. If the birds are then six months old so much the better. It will often be found that some, especially amongst the light breeds, will begin to lay earlier than this, probably at four months old, and the heavy breeds at five months. This is not a good thing. An immature pullet may mean small eggs. There are various reasons for this precocity. It may be the pullets have been bred from a small bodied bird or early layer. Perhaps the food has been of too forcing a character, or too liberal. Measures can be taken to check this early laying. Cutting the rations short or moving the birds will put them off lay. Probably it will put them into a partial or neck moult also, which will keep them out of production for some time. The wisest plan is not to try to stop them laying at all, but to let matters take their course. However careful one has been in mating the breeders, it will generally be found that one or two precocious birds appear and they must be accepted as such. Whilst pullets are in the growing stage, some poultrymen try to keep them back by feeding a mash liberally supplied with bran, and by changing their quarters, if there is available room, which is not often the case.

Laying Quarters.

Since October is the first month in which eggs will be looked for, it is necessary that the pullets should be put into their laying quarters some six weeks before that time, in order to give them opportunity to settle down in their new surroundings. Colony-houses are small movable buildings used entirely for roosting and laying, and into these they may now go on range or into laying batteries, or semi-intensive or intensive laying houses. The colony-houses will not require much preparation, beyond being thoroughly cleaned and having hay or straw in the nest boxes. The laying battery will likewise have had a clean up before a fresh lot of birds are taken in. In addition to nesting material the semi-intensive and intensive houses will need the floor to be liberally littered with straw or peat moss litter; or even bracken may be used if it is available. Probably of these three types of litter, the straw is the best. It will last longer than bracken, and will not make the houses so dirty as peat moss. There should be a good supply of litter, say six inches deep, to enable the birds to do plenty of scratching. Where the pullets are going on to range, and are put into slatted floor houses, the need for perching does not arise, but where there are solid floors, perches will be necessary. In some cases provision is made to teach the birds to perch in their rearing quarters. Where this is not done, they will have to learn in the laying house. It is a mistake to let them perch too early, or on too narrow a perch, as it often leads to crooked breast bones. In most cases in the large houses perches run along the house parallel with the back wall. In others they are placed at right angles to the back. The houses will also have one or two partitions reaching from the back wall to within a few feet of the front, to break up any possible draught. Before coming to the laying house the pullets should have been gradually broken off their rearing mash and put on to the laying ration. If this has not been done before, it should be immediately—but gradually—attended to when they get to the laying house. Should it be desired for any reason to change the system of feeding for the birds coming into lay, this is best done in the rearing quarters, or it may be undertaken directly they get into their laying quarters. When the birds are first taken to their laying house, it is wise temporarily to board up the nest boxes to prevent them from sleeping in them. If this is not done it will necessitate a visit to the house every night to move the birds to the perches, until they have formed correct sleeping habits. It may be found that a good few will at first take to sleeping on the floor and in the corners of the house. This must not be allowed. Unless stopped at once and the birds taught to perch properly, it will be a hard job to get them to do it at a later stage. When the pullets have got used to perching the nest boxes should be opened up and a few china eggs put into them for a time; they can be removed when the birds have come into lay. On no account should the shifting of pullets be delayed until they have started laying.

Perches.

The best size for perches for the laying house is two inches by two inches and the edges should be bevelled. For turkeys the perches need to be a little larger. Where the perches run along the back wall of the house, they should be about 18 inches away from it and there should be a space of about 12 to 15 inches between the rows. It is advisable not to put the perches higher than 30 inches above the floor. Allow about nine inches perching room for each bird. As most of these houses have wooden floors it is usual to have dropping boards fixed under the perches. It is a good thing to keep a supply of sand to sprinkle on the boards to facilitate cleaning. Cleaning the dropping boards should be done at least once a week. On some farms it is done every other day, or twice a week.

Nest boxes which are often fixed along the front of the house just below the windows should be about 15 inches square and about the same height. They should stand up above the floor, so as to allow all the space possible for scratching. These nests, like the perches, should be movable to facilitate thorough cleaning.

In addition to mash hoppers, or troughs, if wet mash is fed, hoppers will be required for grit and also for oyster shell or limestone grit. No birds should be without grit which is necessary to help in grinding the food, and layers must always have access to oyster shell or limestone grit, necessary for the formation of egg shell. It is also a good plan to hang cabbages, or other green stuff, up in the house, for intensively kept birds, especially, will be all the better for a regular supply of this kind of food.

Artificial Lighting.

In order to facilitate and increase the egg yield, many commercial poultry keepers light up their large laying houses during the winter months. Experience over a number of years has shown that the layers respond to artificial lighting. Since the best prices for eggs are obtained during the winter months, it is obvious that anything that will conduce to a larger egg yield at that period will make for larger profits. Where small houses are used on range, lighting cannot be so easily or satisfactorily carried out. There are various lighting methods most of which will give the results desired. One has the alternative of evening or early morning lighting as preferred, the whole idea being to shorten the long winter nights during which the birds get no food. To have second-year birds ready to lay in the Autumn, it will be found necessary to " force moult " them in late Summer. By this is meant the artificial, early production of moulting. To do this, the food is changed about July or August, mash feeding is stopped and only grain is given. If the birds can at the same time be moved to the house they will occupy in the following winter, so much the better. It will soon be found, after this treatment, that the egg yield will have dropped very considerably, though one or two birds will continue to produce eggs. After another week or two, the normal method of feeding can be gradually resumed and the birds should again be in trim for laying by the time October ends.

Birds intended for breeding stock should not be force moulted. There is not the necessity for it because eggs from them for hatching may not be required until December at the earliest, and probably not till February.

Dry mash hoppers are usually made about six feet long. The hanging type is generally fastened to the partitions, and must not be put too high, which will prevent the birds feeding comfortably. A popular type is one which stands up on legs away from the walls, the birds being able to feed on both sides. A hopper six feet in length is of sufficient size to feet 25 birds.

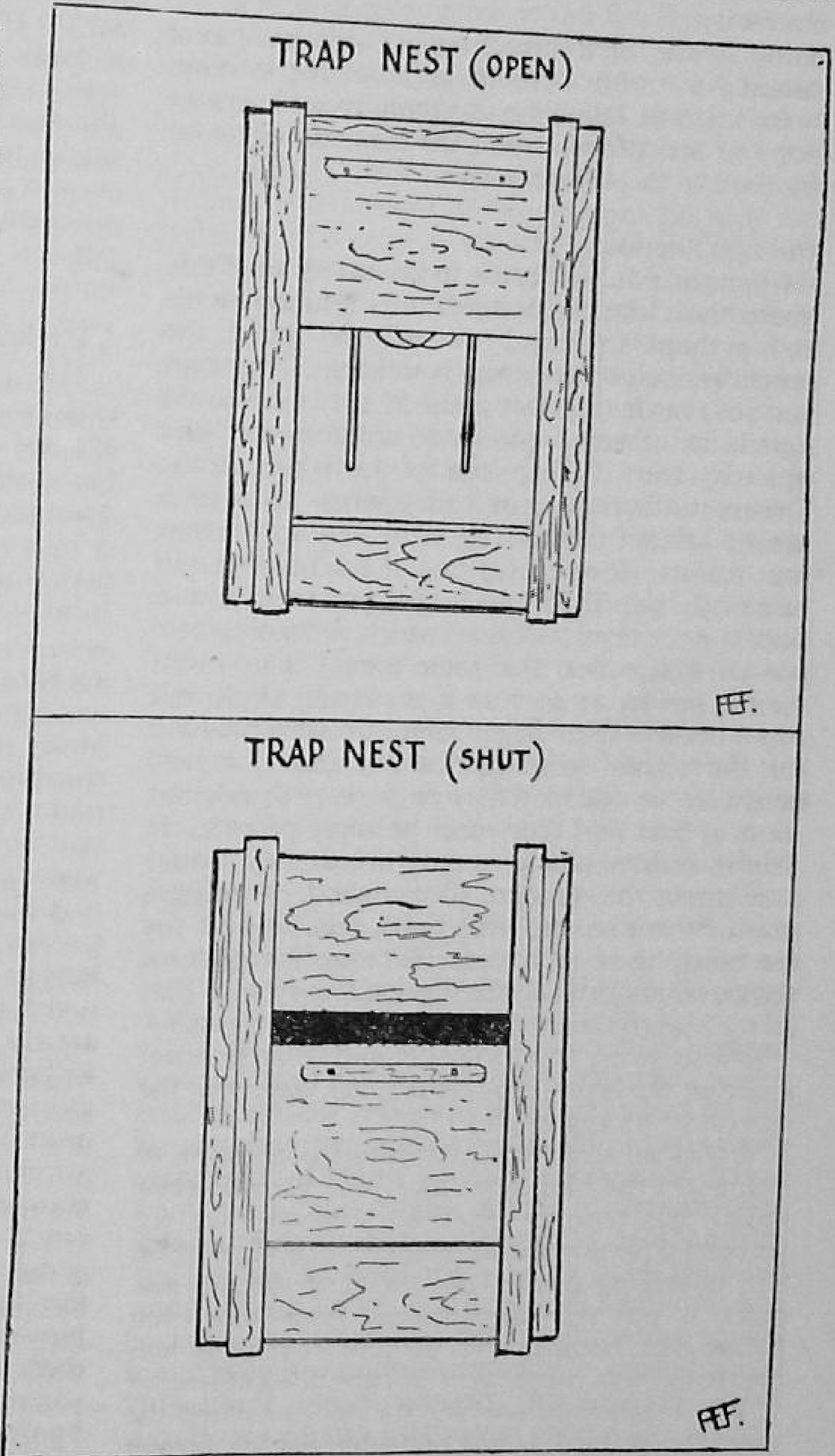


FIG. 20.—Necessary if egg records are kept.

The troughs for feeding wet mash are V-shaped, and many be six feet long, some six inches deep, and the same distance across the top. A trough of this size will give sufficient room for 20 birds to feed.

Broodiness.

Where heavy breeds are kept, a lot of broodiness may occur at different times amongst the laying pullets. This can be a great nuisance, and if not checked can last over a long period. Not only does this mean a loss of eggs, but the broody birds will take up the nests required for the laying bird. These broodies should be removed as soon as found and put into a hanging coop kept at the laying house for the purpose. This coop has a slatted floor with a trough in front for feeding. A few days in this coop is generally sufficient to stop the broodiness, when the bird can again be returned to the laying house.

The Egg Supply.

On most poultry farms, particularly on those where the numbers of birds run into hundreds and perhaps thousands, it will be found the generally accepted practice is to keep 50 per cent first year birds or pullets, and 50 per cent second year birds or hens. On some holdings the hens will only form 25 per cent of the laying stock. The reason is that second year birds, taken as a whole, will not produce as many eggs as the first year pullets. Since the profit of the holding will be mainly dependant upon the egg supply, and since a poor layer will want as much feeding as a good one, it is clear that there should be no room for the former as soon as it is found. On a well run farm, the 25 or 50 per cent of pullets retained for the second year will be not only the best layers, but in addition they must be birds of good stamina and free from any physical defects. If they should happen to be pure breeds they should conform to the standard of the breed. A proportion of these second year birds may be kept for the breeding pens, if there are breeding pens on the farm, and it is of the highest importance that all the birds retained should be of first class quality.

It is knowing what to select and what to reject amongst the layers that contributes largely to the success of an egg farm.

Whilst we shall deal here with the question of examining the birds after they have got into their laying quarters, it must be stressed that for successful poultry farming, selection and rejection will be taking place from the time the day old chick is put into the brooder house—or even before that, because even the type of egg that was incubated was the subject of careful scrutiny.

This business of looking for and removing the unprofitable bird, is known to the poultry farmer as "culling." That it pays to cull is obvious, for it must be remembered that the elimination of poor layers means a reduction in the food bill, It is advantageous to the attendant because he will have fewer birds to handle when he comes to select his breeding stock, and those he actually has to examine will be of the best.

Culling.

Culling can of course go on right through the laying season, but at least once a year, the whole flock must be examined, and that does not mean a cursory examination but handling each bird. If only one culling can be done perhaps the best month for this will be July. By then the birds will have been in lay since the previous Autumn (i.e. October—December). Those that are still in production will probably be the best layers, as it is known that poor producing birds will moult early. If culling can be done earlier as well, say in January and in April, all the better. The final examination will take place when the houses are required for cleaning up, in preparation for the new pullets coming into lay, and when the older stock has to be moved round. When culling is successfully carried out the egg yield should not suffer.

A Paying Proposition.

For birds to be a paying proposition an endeavour should be made to reach a flock average of 150 eggs per bird per year. The higher the average is above this figure the better will the plant pay. The best way to ascertain the egg yield is by way of the trap nest. This is an ordinary nest with a trap door which lets down over the front as soon as the bird enters. It cannot get out until an attendant comes to release it. Then the leg band number of the bird is taken and the egg recorded on a chart kept in the laying house. Many large farmers, and particularly those engaged in the hatching-egg and day old chick trade, practise trap nesting in this way all the year round. It can be readily understood that where a large number of birds is to be trapnested it is almost one person's work to attend to this particular task. It is inadvisable to keep birds too long in the nests, and so many visits to the laying house are required during the day. Then there are the egg records to be made up at some time. Pedigree breeders selling hatching-eggs have in most cases to supply egg records. The enhanced price they get for their eggs and stock is the justification for trapping all through the year. The man in a small way of business cannot always find the time and labour to do this. By way of compromise, he will, instead, trap nest during the four months commencing in October or November, accepting the generally established theory that a bird which has laid during the winter will certainly do so during the Spring and Summer months.

Ringing.

Some farmers who cannot trap nest at all, will ring, say with a blue ring, all birds found on the nest in November, in January they will use a white ring for the birds that lay that month. Similarly a red ring will mark all layers for the month of March. They will assume from this that the birds carrying the three rings are their winter—and therefore their best—layers. Whilst these

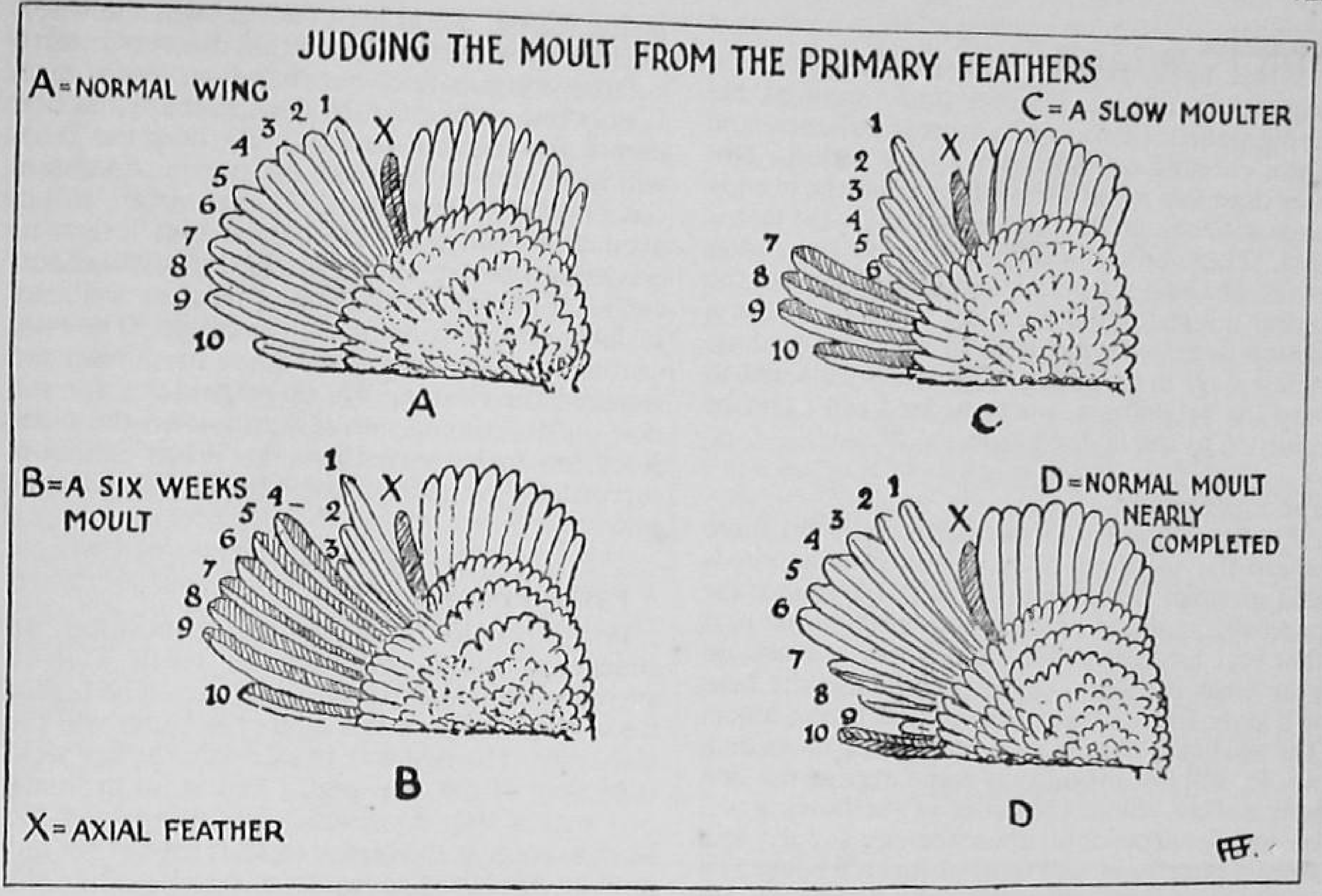


FIG. 21.—A useful guide in finding the layer.

methods of ascertaining the layers are a help, in that the number of eggs laid can be in the one case accurately determined and with the other methods, satisfactorily estimated, they are only pointers because they merely indicate those birds from which second year layers, or breeders, are to be selected by handling. An undersized bird, one that does not conform to the breed standards, may turn out to be a good layer. On the other hand a bird may have given poor results simply through some mistake in management, perhaps from late hatching, or through an error in feeding, and it may seem to be an excellent bird when handled. Where no trap nesting or ringing has been done, a guide to present or past laying can only be ascertained by handling and inspection. There are now fairly well accepted rules which will help in the matter, any one of which will point the way, but all of which must be taken together before a definite conclusion is reached.

Yellow Pigment.

We are very much helped in the matter by birds of the pigmented breeds, i.e. those that carry the yellow pigment (xanthophyll) in the skin, legs and beak. In this class are the Leghorns, Wyandottes, Rhode Island Reds and others. At the beginning of the laying period this yellow pigment will be plainly seen in the beak and legs. It will also be found in the vent. When laying commences, the pigment, which is obtained from such food as yellow maize and green plants, and has been stored in the body previously, will now be required for the yolks of the eggs. As laying becomes more frequent the pigment is drawn on to a greater extent, and it will be noticed that the yellow colour begins to fade or bleach out from the various organs in a definite order. The vent will first lose its colour followed by the eye ring, the ear lobe, the beak (starting from the base) and finally the legs. When laying ceases the yellow pigment returns to the body in exactly the same order. Absence of colour in yellow fleshed breeds will denote previous egg production. From work done in the past, it is now possible to guage the approximate time it will take for various parts of the body to bleach out, and to determine from this whether the bird is laying and how long she has been in production. The vent will become completely bleached in about a fortnight after laying is in full swing. Six or seven weeks will find the colour eliminated from the beak, but the shanks will not be entirely bleached until after about five months continuous laying. It must be remembered in this connection that certain factors will affect the degree of pigmentation. Among these are feeding and management. A bird receiving a liberal allowance of maize, and with access to a nice grass run, will be richer in yellow pigment than one kept intensively, or receiving a mash devoid of maize. This must be taken into account and allowance made accordingly, when culling is in progress. There are other points all of which will have to be

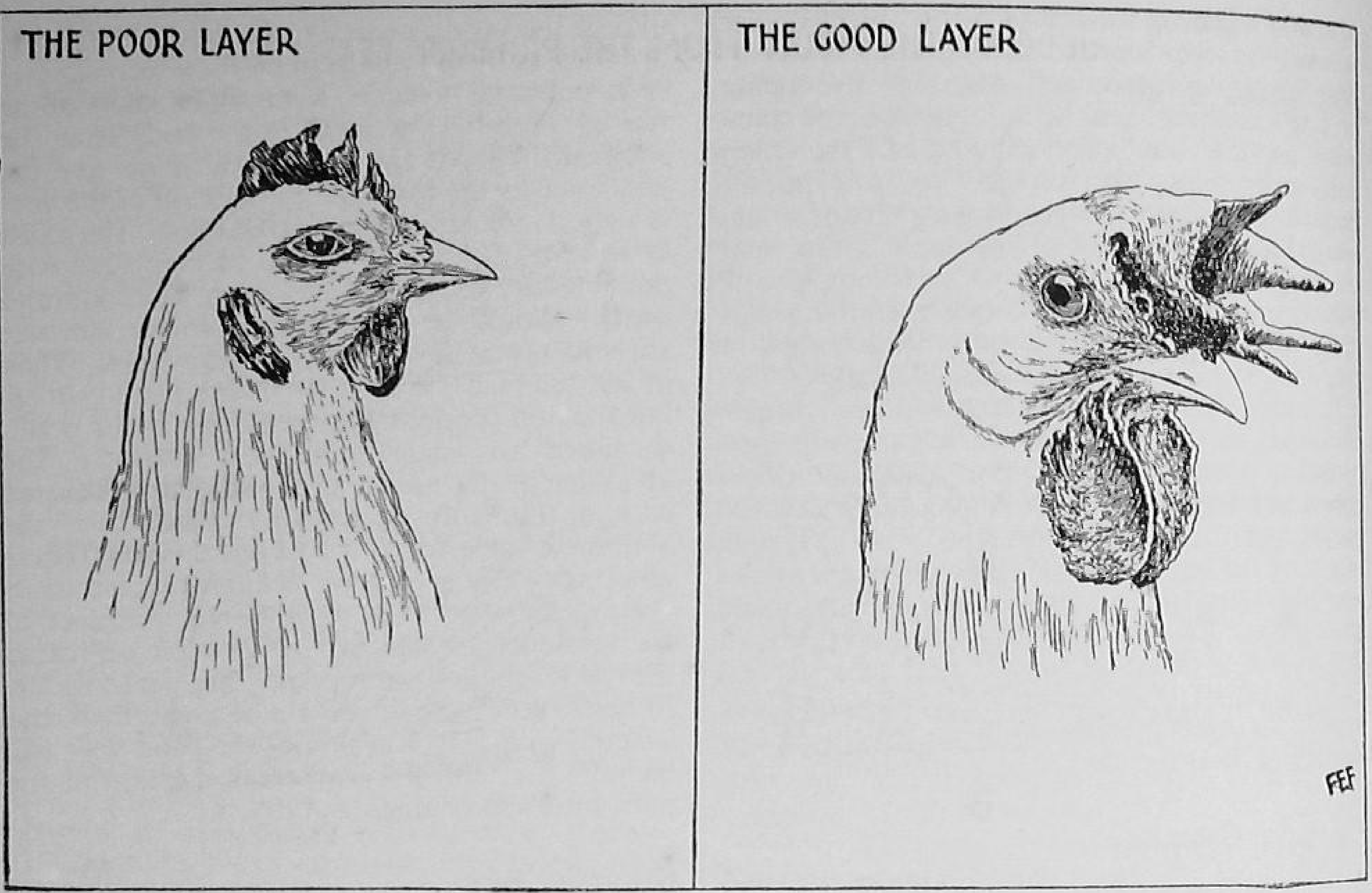


FIG. 22.

carefully taken into account where the trap nest has not been used and the birds are of the white flesh variety:—

Briefly the points for examination are :—the moult, distance between the two pelvic bones, distance between the breast bone and the pelvic bones, length of breast bone, depth, width and size of body, condition of vent, comb and wattles, condition of abdomen and head, fineness of bone, condition of pelvic bones and texture of skin.

The Moult.

In white fleshed breeds, past production can be judged mainly by the moult. It is generally accepted that birds producing the most eggs are the late moulters, that is birds which have laid all the previous Winter, through the Spring and Summer and do not begin to shed their feathers until the Autumn. Birds moulting early in the Summer should be eliminated from the flock. It takes about six weeks for a feather to grow out in either a good, or bad, producer, but the good bird will grow more feathers at a time, thus completing the moult quicker. When the bird is moulting the feathers are usually shed from the head and neck first, then the breast, body and wings, and from the tail last. The new feathers will begin to come as soon as the old ones are dropped. Care should be taken in the feeding during the moult. A bird must be kept in good health and in good body weight while the feathers are growing.

Sometimes birds hatched early in the season will, after a short term of laying, have a partial moult, in the Autumn of the year in which they were hatched. Production will generally stop when this occurs. This is especially annoying as it is the period when in normal times eggs are making their top prices. The best way to counteract this trouble is to avoid early hatching if possible.

The Plumage.

If layers are being selected in August or September the condition of the plumage should be noted for the good layer. The feathering will usually have a dilapidated appearance from many visits to the nest. The early moulters will on the other hand show signs of new and fresh looking feathers. New quill feathers are large and sappy in appearance, the old ones are hard and hollow.

It is possible to estimate when the moult began by counting the primary feathers in the wing. The primary feathers are those on the outer end of the wing, those known as the " secondaries " are on the inner part of the wing and running up to the body. They are divided from the primaries by what is known as the axial feather which is much shorter. The average bird has about ten primaries and fourteen secondaries. When a hen ceases laying in the summer, she will usually shed the primary feather lying next to the axial feather. If she is an early moulter she will probably drop the second primary feather two weeks after the

first, and will drop the rest of them, one by one, at intervals of two weeks. The primaries always drop in numerical order. The high producing, or late moulting hen, will moult on the same lines as the late producing bird, the main difference being the rapidity of the moult. Instead of renewing her primary feathers one after the other, several of the same length may be growing at once. So that in attempting to calculate the length of time since moulting began, these new primaries of the same length must be taken as one.

In estimating the time since the moult began, allow six weeks for the first complete new primary, and two weeks for each additional complete primary. A wing having three new full grown primaries will show the bird has been moulting for ten weeks. If none of the primaries are fully grown the estimate must be made allowing for this, on the basis that two thirds of the growth is made during the first three weeks, and the other third during the remaining three weeks. So that a half grown primary would show about two weeks growth (see illustrations).

Abdominal Capacity.

To find out whether a hen is in lay or not, and if in lay, the extent to which she is producing, the abdominal capacity must be ascertained. The abdomen is the rear section of the body and contains most of the digestive and all of the reproductive organs. The abdominal capacity is taken between the pelvic bones (the two small bones at the side of the vent) and the end of the breast bone or sternum. To measure this capacity, see how many fingers can be placed between the pelvic bones and the end of the breast bone. If you have to use four or five fingers the bird is producing rapidly, or in other words is a high producer. If on the other hand the distance can only be measured with say two fingers, then the bird is not in profitable production. The measurements are of course only a guide to whether the bird is in lay at that particular time, and to what extent. It is no guide to past production. The distance between the pelvic bones themselves are a guide to laying. If say three fingers can be placed between them, then the bird is probably laying well, whereas if only say one finger can be used in measuring, the bird is not laying at all, or is producing very few eggs.

A Good Layer.

A short breast bone is not considered a sign of a good layer, and if one considers a little, the reason for preferring a long breast bone is fairly obvious. As a bird comes into lay, the abdomen expands because of the enlargement of the oviduct and the intestines, and a long breast bone is better able to carry what is rather a heavy weight. The length of the breast bone is not a sign of the laying capacity of a bird. Naturally, in choosing birds to be kept on for a second year, or as potential breeders, note will be taken of the size of the bird, the depth of the body from the back to the front end of the keel bone, and the width across the back. The condition of the vent is a good indication of egg production. The moist large vent of the layer should be compared with the small dry vent of the non-layer. The comb and wattles should be noted. Their colour and size are evidence of the activities of the ovaries. When in lay, the bird will have a red comb and wattles, but the non-producer can be known by its small, shrunken and pale comb and wattles. The abdomen of the layer is silky and pliable, covered with a thin soft skin. In the non-layer the abdomen tends to be hard with the skin coarse and thick. The good layer will have a keen sharp eye as compared with the listless appearance of the non-doer. Prolonged production will cause the pelvic bones to become thin and pliable. In non-layers these bones will be found thick and covered with fat. The skin of the good-doer will be soft, thin and silky, whereas the skin of the poor bird will be thick and dry.

Discarding Birds.

If attention is paid to all these points, and birds are carefully handled and examined several times during their laying period, and known non-doers are eliminated, there should not be much difficulty in making a final selection at the end of the season. A farmer will naturally know and take into account when discarding birds, the whole of their life history, where there has been any error in management, or feeding, and the date the birds were hatched. Any one of these points may be the cause of non-production.

Handling.

In the method adopted for culling, care must be taken in handling the birds. Fowls are very nervous, and any rough treatment may result in a drop in the egg yield. Some people cull at night, taking the birds from the perches for the purpose. Probably a far more efficient job is made of it in the day, when everything can be seen clearly. The best method in the latter case is to use a catching crate. This may be some 5 ft. long by 2 ft. wide and 2 ft. high, and will want both a trap door in the top and a movable end. The crate is placed outside the exit, about 24 birds are driven into it, and the end closed. The birds are ready for inspection.

Instead of the catching crate a wire-netting surround may be used inside the house, one edge of the netting being fastened to the wall near one of the corners of the house. After some birds have been driven into the corner where the netting is attached, the other end can be fastened so as to enclose the birds. The culler, inside the wire pen, can now select his birds.

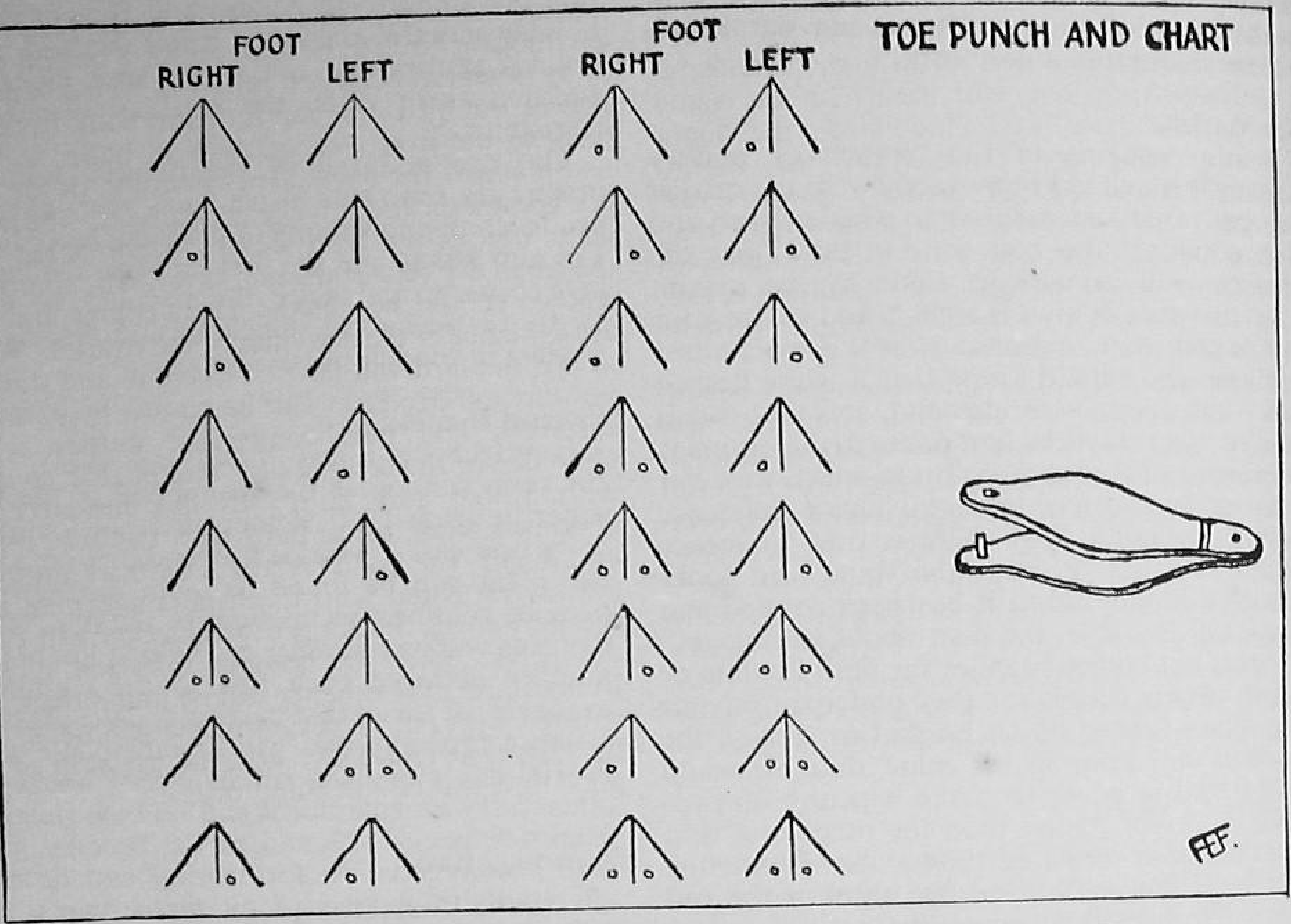


FIG. 23. Method used for identifying the progeny of particular matings.

TABLE POULTRY

What is a Table Bird? The best Table Breeds. The importance of colour. The trough-fed bird. Cramming or forced feeding. Killing and plucking. Cooling and packing for market. The Capon.

To the uninitiated, Table Poultry may simply mean birds that have ceased to provide eggs for the table, and are only fit to be eaten themselves. Birds in this category certainly do find their way to the table—and rightly so! If they are partly boiled before roasting, they make a nice meal. Where they have been indifferently cooked they are far from tender, as many who frequent some restaurants—not the best—will know.

A Real Table Bird.

To the trade, a real table bird is one that comes from a breed well-known for its good qualities, i.e. one that carries the maximum of breast meat. After being reared and brought along to about 16 weeks it has then been subjected to a term of fattening for two or three weeks before being killed and marketed. Up to about 25 years ago this fattening business was in the hands of a comparatively small body of men located in the Heathfield district of Sussex, and it was a trade usually handed down from father to son. The finishing process was a skilled job. These men rarely reared their own stock, but went round to small holders and cottagers to select likely birds for the work. Where they did not go themselves they employed "higglers" to do the buying for them.

"Surrey."

The type of bird these men marketed was known as the "Surrey" to the trade, not because it had any connection with that county but because it was the name for the finest type and best-finished bird placed on the market. It had always been fattened usually first by trough-feeding for a term, and then finished off by a further term of forced-feeding or cramming. These old professionals knew exactly when the bird was "ripe" for killing, and when any further feeding would result not in gain but in loss of weight and condition.

Table Birds Alone.

When poultry farms began to increase to such large numbers after the Great War of 1914–1918, many people took up the production of table-birds alone, leaving egg farming to others. They differed from the Heathfield fattener in that they reared as well as fattened their birds. This branch of the industry had a lot to commend it. One important factor was the quick turnover of capital. The birds were on the holding no more than 16 or 18 weeks before being marketed. The

housing was not such a big and expensive item as that required on an egg farm, nor was such a large area of ground necessary.

The Market.

Before engaging in this branch of poultry farming it is well to know exactly what the market requires. Opinions differ as to whether such and such a bird is the best for the table, but the producer will be wise to abide by the maxim " the customer is always right " and to see to it that he gets what he wants. Now it is maintained by those who should know that a white fleshed bird is the one most in demand, and that this is the bird that makes the best prices in this country. Here is one of the many points in which we differ from our American cousins who have a preference for yellow flesh. Why there is this preference cannot be said. Perhaps the white bird looks better. Certainly when it has been roasted and placed on the table, the man about to dine will probably not bother whether the flesh is white or yellow. Many people say they prefer the flavour of a yellow-fleshed bird. Be that as it may, the producer will keep in his mind that his white fleshed bird is going to make a penny or two-pence more per pound than the other one, and if he thinks in terms of thousands of potential table birds, and of his balance sheet at the end of the year, he will act accordingly.

This preference for a particular colour limits the choice when looking for the best breeds for the table and the prospective table poultry farmer will do well to study the different breeds and cross-breeds, both in the pen, and if possible at the Shows, before making his decision. If breeding stock is going to be kept it is of importance, in making a choice of breed, to find one that will produce a satisfactory number of hatchable eggs, and it is in this respect that the Light Sussex breed fills the bill. The progeny of the Rhode Island Red (male) crossed with Light Sussex is in much favour at the present time both for eggs and the table. Assuming this cross is taken up extensively by the breeders and hatcheries, it should be possible for the table poultry farmer to get a regular supply of day-old cockerels of a very satisfactory kind for his work, for the greater part of the year, and it should not be difficult for him to arrange for a supply for the rest of the time, even if he has to pay a bit extra and take pullet chicks as well, for that interval.

Supply and Demand.

In pre-war days the peak prices for table birds coincided with what is termed the " London Season," a period which extended from the end of January until the end of July. It also happens to be the " close " season for game. Never was there a glut of properly fattened birds during that time. The demand always exceeded the supply; indeed the supply of table birds for many years did not exceed one bird per head of the population per annum. In August and September, the holiday months, there was a fair demand in the holiday resorts, but not in the large cities. In addition there came the seasonal demand at Christmas.

The rise and fall of the market, following practically the same curve each year, gave the producer an opportunity of planning accordingly. The aim was to put the first birds on the market in February, and since these would be about 16 to 18 weeks old, hatching and rearing had to start in the fall of the year.

Planned Routine.

It might be asked " Did not these 'fall' chickens, coming at the wrong end of the year, suffer in quality " ? Practice has not found this to be the case. Working operations on a well run plant will be found to fit in nicely with a planned routine. Incubation, or the purchase of day olds will be necessary each week, limiting the number obtained each time to the equipment available for use at that particular date. Take for instance brooders that will accommodate about 70–100 day olds from hatching to 4 weeks old; other carry-on equipment will be then necessary from 4–8 weeks (the end of the brooder stage) with accommodation for rearing and fattening afterwards. Supposing for example that it were desired to market 80 birds per week, then one should purchase, or hatch, say 100 day old chicks per week. This would take one brooder which would be occupied for four weeks, and since chicks would be coming in weekly, 4 brooders would have been used up before it were possible to start on number one again. It would be necessary to have a fifth brooder if proper allowance were made for cleaning up, and for not running things too closely. The other equipment required may be worked out in a similar way. A point to remember in connection with the autumn chick, if one is using incubation, is the number of eggs likely to be obtained at that time of the year. It is not the flush time of Spring when practically any kind of bird will lay. The older birds that have laid through the Spring and Summer will probably be moulting or resting and it will be found that a larger number of breeding birds will be required in the Autumn than in the Spring. A good many producers get over this difficulty by breeding from pullets that are just coming into lay, and provided the incubated egg is carefully chosen for size, it will not be found a detriment to use these pullets' eggs. It is not as if the chicks to be hatched from them were to be reared to become potential breeders. They would be marketed for table in the usual course.

Brooding and Rearing.

The brooding and rearing of table chickens will follow the same lines as those employed in other branches of the industry. The equipment required will be similar to that described for other young

stock. Feeding will also follow the same lines. There is still a prejudice in some quarters against dry mash feeding in the rearing of table birds. It is protested that dry mash feeding results in a small crop which will not respond to good work when fattening takes place. Experimental work has not found that objection to be justified and birds reared on this system of feeding have fattened quite as well as those reared on wet mash.

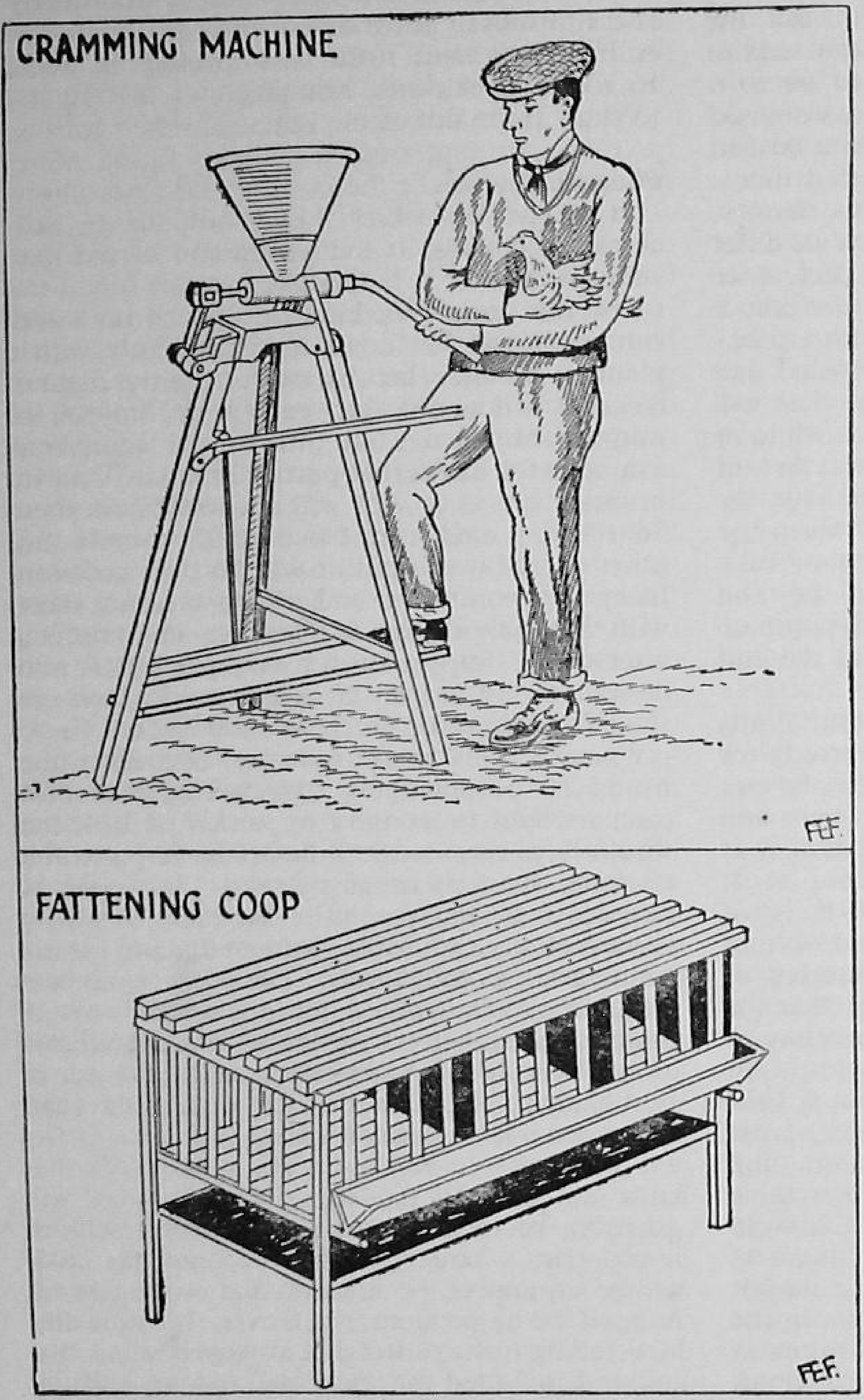


FIG. 24.—*Above.*—Cramming is profitable in experienced hands. *Below.*—Coop fattening gives good results.

Special Feeding.

It is in the final stages of producing the finished table bird that the table poultry farmer must have resource to special feeding. This part of the work will not be satisfactorily done if dry mash feeding is relied on for fattening, neither will any amount of good wet mash avail if the bird is allowed an extensive range. True, you will get quite a good table bird if you leave it in its rearing quarters, restrict its run, and feed a good wet mash two or three times a day. It is even possible to kill a bird straight from rearing, without any fattening at all, say at about 16 weeks or over, and produce a presentable carcase. These are not " Surreys " however. For this trade, the birds should be picked up and put into cages or crates for soft feeding. Soft feeding will then be carried on over as long a term as the birds will readily consume all that is put in front of them, say in about half an hour. Generally two meals a day are sufficient, morning and evening, though some fatteners give an additional light meal at midday. Never leave food about so that it is in front of the birds all day. If they clear up the meal quickly, give a little more next time, if they leave part of their food, then reduce the next meal accordingly. It may be found, when birds have been reared on dry mash, that they will not readily take to this sloppy wet mash mixture. This difficulty can easily be overcome by starving the birds for 24 hours when they first come into the cages. Various mixtures may satisfactorily be used in fattening. In the past the mainstay of the fattener has been a mixture of Sussex Ground Oats and Milk, and it is still considered the best food for the purpose by many engaged in the business. The exact proportions to be used, and other mixtures, are indicated in the section on feeding. The preparation of the food must be carefully done. It is usual to use tubs for the purpose. The water and milk are first mixed until all lumps are broken up. Then the S.G.O. are gradually worked in and stirring is carried on during the process, with a long wooden mixer specially made for the purpose, until the mash has reached the consistency of thick cream. The food should be prepared the day before it is required for use, to allow it to ferment during the night. This stage of the fattening is known as trough feeding, and if it is desired to market the birds after this period is complete, it is usual to leave them feeding for as long a period of days as they will do so readily. As soon as their

interest in the meal begins to flag it is best to kill and market the birds at once. No hard and fast rule can be laid down as to the exact number of days this will take.

Cramming.

Where, however, forced feeding or "cramming" as it is known, is to follow the trough feeding, then the fattener will usually take the birds off the trough at ten days or a fortnight. Rarely are birds crammed for longer periods than a week, and where a fattener knows his work that time should suffice. The mixture used for cramming is the same as that for trough feeding, except that at this stage of the fattening, mutton fat—rendered down—is added. Cramming, as its name implies, is forced feeding, and it is usually done in this country by means of a machine (see illustration). It is in cramming that the skill and experience of the fattener tells. He takes the bird under his arm, and with one hand opens the mouth and inserts a long rubber tube into it. The tube is connected with a container on the machine, into which the food has already been poured. This food is next forced from the container into the rubber tube and into the bird's crop by means of a treadle worked by the fattener's foot. With his free hand on the crop of the bird the fattener has all this time been judging when it has had sufficient, or all that it is desirable it should have, and with his experience he will usually know this to a nicety. Cramming takes place twice a day. It has been suggested at various times that cramming is cruel, that it causes unnecessary suffering to the birds and that it is prohibited in some countries, and should be in this. The writer can say that in his experience over the course of many years—during which he has had thousands of crammed chickens pass through his hands—he has not seen any evidence of cruelty. Only on one or two occasions has he known of the death of a bird as the result of cramming. Of course it is not work that should be engaged in by an amateur. It should be left to the experienced hand. "Does cramming pay ?" it may be asked, and the answer is undoubtedly "Yes," in the hands of the right person." A good crammer can add as much as 16 ounces to the weight of the bird in a week's forced feeding, to say nothing of the improvement in texture which fattening brings, an improvement which makes for an enhanced price per pound in the market.

Coops or Crates.

A word must be added about the crates used for fattening (see illustration). These are usually made of wood, open fronted with bars down the front so that the birds can get access to the troughs hung in front of the crates. The crates have slatted floors through which the droppings pass on to a board and these facilitate cleaning. The coops are generally divided into three compartments, each usually taking five birds, or fifteen in the whole coop. Some fatteners prefer to have these coops, or crates (which may be single or two tiered) in the open in the shelter of a wall; but in any exposed situation it is best to have them under cover; a shed provided with plenty of shutters which can be opened during the feeding and closed afterwards is often used for the purpose. Some authorities consider better results are obtained if the birds are kept between meals in semi-darkness and quiet.

Where birds have been fattened in their rearing quarters out on range it will be found more satisfactory to make the mash up into a crumbly condition instead of to the consistency advised for crate-fed birds. It is easier then to remove any food left over from the meals.

We have recommended here that birds should be marketed at 16–18 weeks of age. This course is suggested in order to meet a fairly regular demand throughout the year for a four-pound dead-weight carcase. At Christmas a larger bird is in demand, and in the past a small bird known to the trade as a *petit poussin*, which weighed about one pound to one and a half pounds and was about 10 weeks old, made a ready market in the spring months. Whether it paid to kill them off at that early age rather than carry them on, is a moot point, but it proved a very useful trade to anyone having to get rid of surplus cockerels in order to make room for growing pullets.

When fattened birds are ready for market, the first and important thing is to starve them for 24 hours in order to get the crop, and if possible the intestines, empty before killing. Birds go to the wholesale markets rough plucked, that is minus their feathers and stubbs. The birds are only dressed (i.e. the offal removed) for retail customers. Consequently, unless the birds are empty, they are likely to get discoloured, or go green as it is called, during transit to the markets, and if bad are likely to be condemned, with a loss to the producer. Particularly is this the case during the hot summer months.

Killing.

Killing can be done by sticking, as is practised in countries where birds have to go into cold storage for export. This method is used so as to drain all the blood from the carcase. If this is not done the flesh is apt to be discoloured when the carcase is required for the table. A long knife is used. It is inserted in the mouth, the roof of the mouth pierced and the jugular vein cut, practically in one operation. "Is this a cruel method ?" it may be asked. It would be, if practised by an inexperienced person, but in the hands of the professional it is almost instantaneous and there cannot be any suffering. The writer has seen this done on many establishments both in this country and abroad, and at no time has he seen the operation done otherwise than in a proper humane manner. In this country birds are quite

commonly eaten the day after they arrive in the market, and so killing by dislocation of the neck is the usual practice. To kill a bird by this method take the legs, wings and tail in the left hand, grasp the back of the neck with the right hand as near to the head as possible. The head should them be through first and second finger and resting on the palm of the hand. A steady pull downwards with a slight turn of the head upwards will then dislocate the neck, leaving a small cavity near the head into which the blood will drain. It is necessary to keep the bird's head downwards until the blood has drained away. This method can be done easily and quite quickly after a very little practice and there is no cruelty attached to it. Care must be taken, however, to see that the neck is properly dislocated. The writer has on more than one occasion seen birds offered for sale that had merely been strangled, a practice for which there cannot be the slightest excuse.

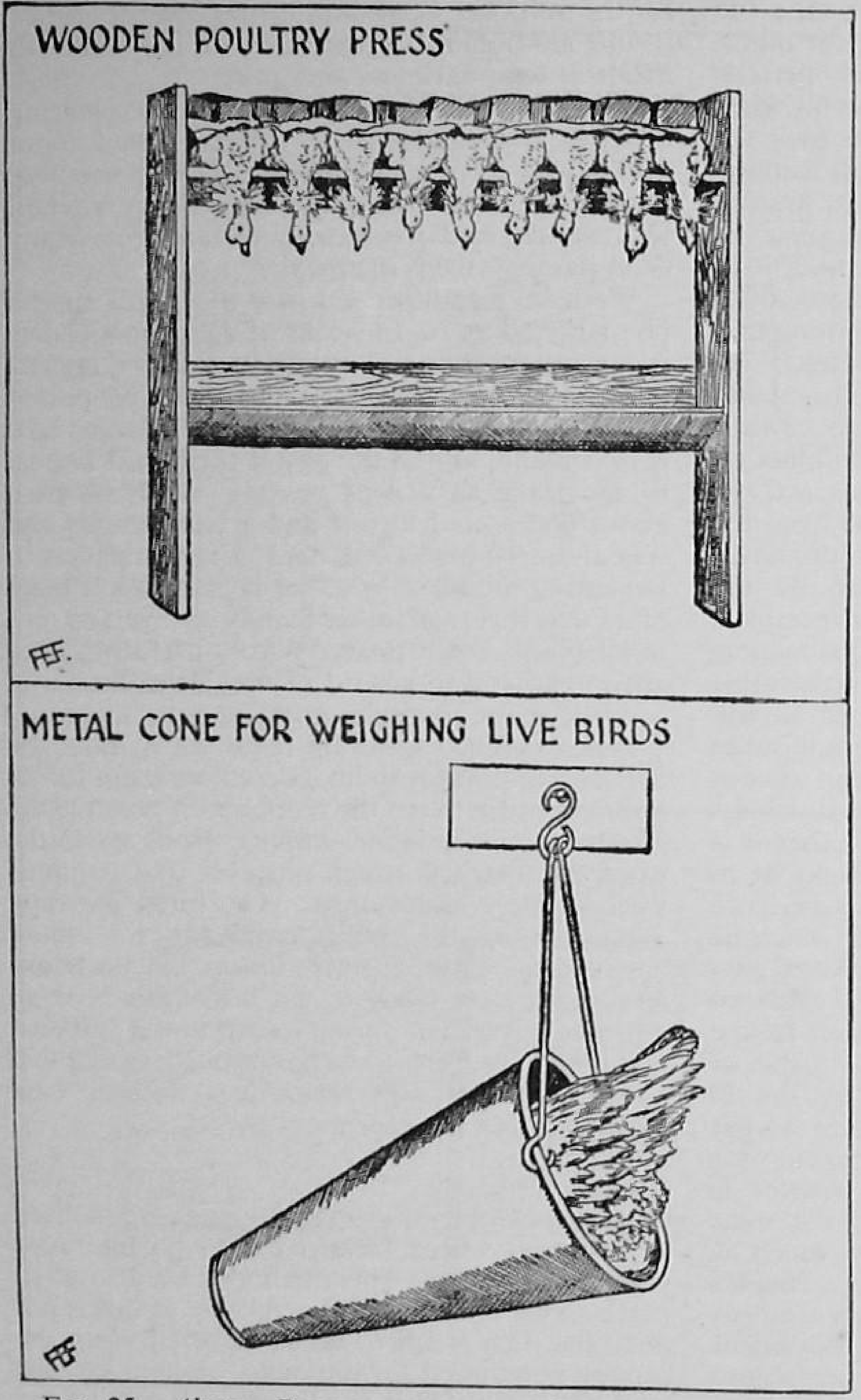


FIG. 25.—*Above.*—Presses are necessary for shaping the carcase. *Below.*—This saves a lot of time when weighing.

Plucking.

Plucking takes place immediately the bird is killed, and an easier job will be made of it, and a cleaner one, if it is performed whilst the carcase is still warm. This work can be done by machine or where the output does not warrant the use of the machine, by hand. A method used just before the war on some farms was wax plucking. The bird was dipped for a second or two into melted wax. It was then hung up until the wax was properly cooled. The wax could then be peeled off the carcase, taking the feathers with it and making a satisfactory job of the work. At the time this method was introduced it did not seem possible to reclaim either the wax or the feathers, making it rather an expensive process; but probably this will be remedied in time. Some fatteners before hand-plucking dip the carcase for a minute into boiling water. This facilitates the removal of the feathers, but it is said to take the bloom from the bird also. A good fattener will hand pluck as many as 15 to 20 birds per hour according to size. It is of course work that calls for experience. Quickness in plucking without tearing the carcase comes readily to the young beginner after a little experience. An old fattener known to the writer always ruffles the feathers before beginning operations. Then grasping the legs and wing feathers in one hand and keeping the skin tight, proceeds to strip the feathers up each side of the breast to the neck. The breast itself is then dealt with, afterwards the legs, the tail, and finally the back and wings. The removal of the stubs, undeveloped or pin feathers, is often left to casual labour on a large plant. Women usually do the work at a penny or three-halfpence a bird. It does not call for experience, but rather for patience. A blunt knife is usually used for removing the stubs. It is essential that all this work be done as early in the day as possible, so as to allow plenty of time for the birds to cool off

before being packed for market. They require at least three hours to be cooled. Cooling and pressing into shape takes place at one and the same time. Many presses are made of wood. They consist of two shelves joined together to form an angle a little less than a right angle. As a rule these are built up in tiers. Into the troughs thus formed the birds are pressed breast down, with the head of the bird hanging down in front of the trough. The carcase must be pressed well in against the back board. A board is then placed over the backs of the birds, with some heavy weights (usually bricks) on top. Metal coolers are now on the market and these are a great improvement because they are jacketed to allow water to flow through them, to make a better job of the cooling. In thundery weather it is customary in some fattening establishments to "rope" the chickens. This trade term means to remove the intestines, and it is done to make doubly sure the carcase will not go green during transit. The intestines can be removed through the vent with the little finger or a button hook. Care should be taken not to break them during removal. This removal will mean a little loss in weight, but it pays in the long run. Some distributors will allow for weight when roping is done.

Packing.

After the cooling comes the packing for market. There are two methods, the old one, and still in much use in this country, by means of the Sussex ped, which is a returnable crate made of wood, and the more modern way of the non-returnable package, an idea introduced from the continent. This non-returnable box is made of light wood and will contain 6 or 12 birds packed in one layer in grease-proof paper, as compared with the Sussex ped which will take 12, 18 or 24 birds packed in rows one above the other, breast down, with a thick layer of straw or bracken between the rows, at the bottom, and over the top row. The non-returnable package is closed with small nails, the Sussex ped with string. Birds are usually sent off by the evening train in order to arrive for the next day's early market.

It is a mistake to consider any bird will do for fattening. The experienced fattener can only make a first class job when he is dealing with good healthy stock.

THE CAPON.

Advantages.

No article on table poultry would be complete

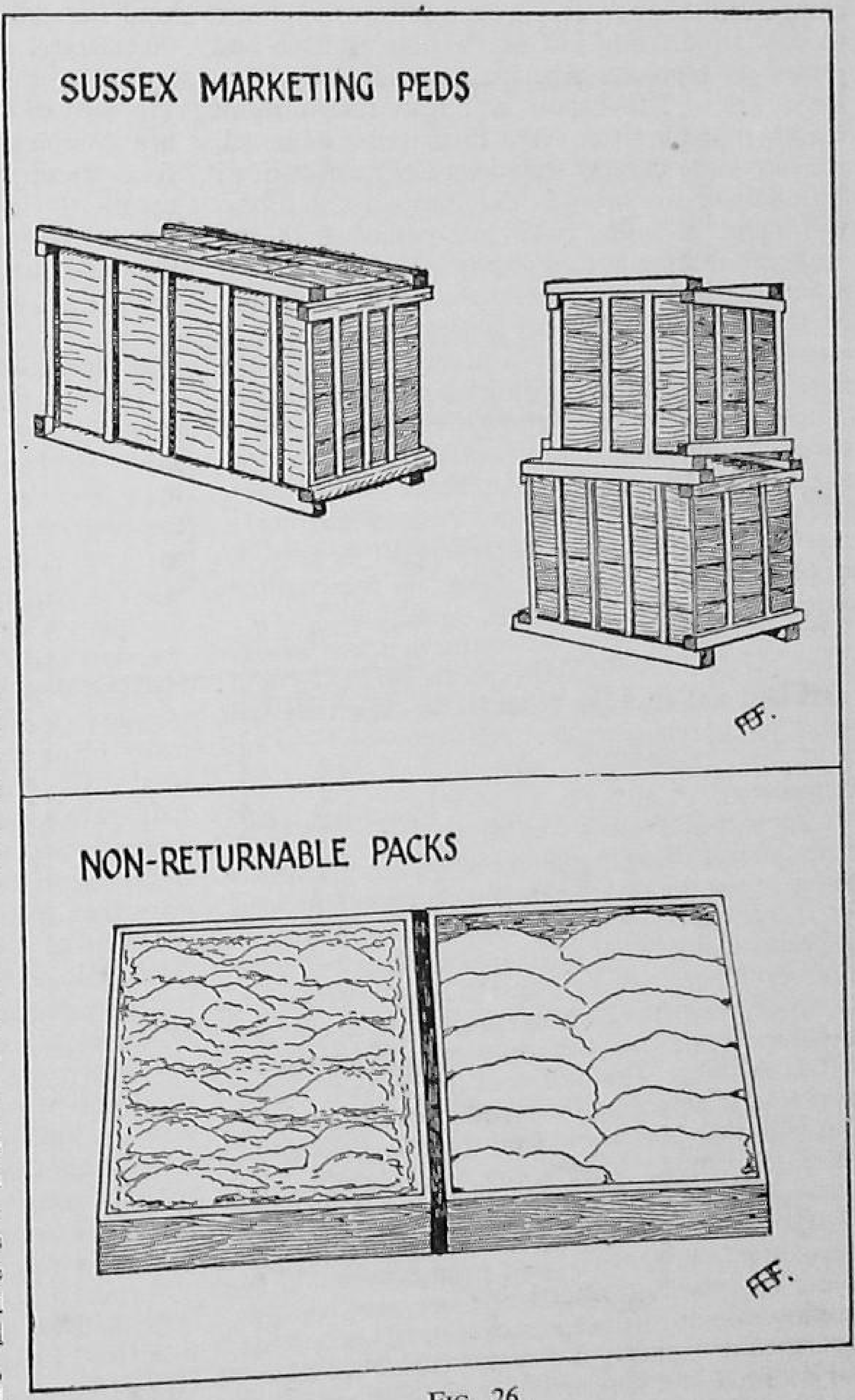


FIG. 26.

without mentioning the Capon. This is of course a castrated male chicken. As with other animals so treated it will differ in many ways from the cockerel. The bird properly caponized will seldom crow, the comb and wattles cease to grow. The hackle and saddle feathers grow very long, the plumage taking on a glossy appearance. It is said that the capon makes an excellent

broody. It is not often come across now-a-days. That it has been a favourite dish through the centuries we know, for does not Shakespeare speak of " the justice, in fair round belly with good capon lin'd." It is said that it has a superior flavour to an uncaponized bird. Over the ordinary cockerel the capon has many advantages. It is quieter in disposition, showing no inclination to fight, does not want much exercise, and stands close confinement well. As a result of this desire to stay around and just eat he puts on flesh and grows to a greater size than a cockerel of the same age. The capon will also fatten more readily than the latter. Why then, it may be asked, are not more capons found on the market now. The answer probably is that though the capon will make a better price per pound than the cockerel, it is open to question whether it makes a higher profit. A cockerel should be marketed by the time it is 20 weeks or five months old, in most cases it is marketed a month earlier. Kept much longer than five months it will begin to get " staggy," with a consequent drop in price. The capon on the other hand is often not at its best until about 10 months old. There is not much evidence available as to the cost of feeding a capon up to the time of marketing. If kept in large numbers, they will take up room often required for other purposes.

It will thus be seen that quite two and nearly three batches of cockerels can be produced and marketed one after the other by the time that one batch of capons is ready.

Caponizing.

Caponizing is fairly simple to learn. Though experts can probably manage without, it is much better to use the set of instruments especially sold for the purpose. It is advisable for the beginner to practise at first on dead birds, which will give him confidence. If he can see a demonstration so much the better. After practice it should be possible to carry out the operation in from ten to fifteen minutes. The bird does not seem to suffer pain to any extent as the result of the operation, and will walk about and feed directly after it has been performed. Losses due to caponizing can occur with the most experienced, but should not exceed five per cent with anyone after practice. Very often, particularly with beginners, it will be found that the bird after being operated on, will develop like an ordinary cockerel. This is what is termed a " slip." A " slip " is neither capon nor cockerel, but between the two. The condition is due to the operation not being performed properly, a small part of the gland being left in the body.

Suitable Breeds.

It is said that large breeds are the best for caponizing. A breed would not, however, be kept on a poultry holding simply for producing capons, but rather the bird used would be the surplus and unwanted cockerels of the egg farm. In the case of this country the breeds used therefore would most likely be Leghorns, Wyandottes, Rhode Island Reds and the like. The time of the year for caponizing is of little importance. The fact that the capons would probably be most in demand round about Christmas, owing to their size, suggests that cockerels should be chosen from the earliest hatches. The age of the birds and size should be the deciding factor as to when to operate. The best time is when they weigh two or three pounds and are about three months old. No bird should be caponized until the intestines are completely emptied. This is important, so food should be withheld and the bird kept shut up for 24 to 36 hours before the operation. A good strong light is necessary so that the organs of the bird can be clearly seen, and a sunny day when the work can be done outside is best.

The Operation.

To hold the fowl down, put a noose of strong string round the legs. Treat the wings in the same way about the shoulder joints. Weights must then be attached to these and passed over the opposite sides of the operating table to hold the bird down and spread it out. Moisten and remove the feathers over the last two ribs just in front of the thigh. With the left hand slide the skin and flesh downwards towards the thigh. Holding it in this way, make the incision between the last two ribs keeping the edge of the knife away from you as you stand at the back of the fowl. The cut should be one inch to one and a half inches long. The spreader (from the box of special instruments) should next be inserted in the incision so as to spring the ribs apart. The intestines will then be visible covered by a thin membrane. Break this membrane apart with the hook, and the upper testicle, about the size of an ordinary bean, will be seen close to the backbone. Now comes the important part of the operation, An artery which runs at the back of the testicle must not be ruptured on any account, because if it is, the bird will bleed to death. The testicle has to be caught up and secured by the spoon forceps without getting hold of the artery as well. Having secured the testicle twist the instrument round several times, tear it away from the body and remove it. Experts at the work can remove both testicles from the one incision, and in doing this they always remove the lower testicle first. Operators with little experience should not attempt this for some time but should turn the bird over and make another incision for the removal of the second testicle.

After-Care.

After completing the operation, if bleeding is profuse, remove some of the blood with pieces of absorbent cotton introduced into the body with the aid of the tweezers, removing them when saturated. Be sure that no feathers or

any other foreign matter is left in the wound. Then take out the spreaders and allow the skin to slip back over the cut. The bird should then be placed in a clean pen or house, being kept quiet and not allowed to roost. Give water and soft food mixed with sweet skimmed milk. For a week or ten days the capon should be watched to see whether it becomes wind "puffed," that is whether it develops a gathering of air under the skin near the wound. If that occurs it must be dealt with by pricking the skin with a needle or clean knife. In about ten days or a fortnight the incision in the body should be completely healed. No stitching is required. For several months after being caponized, the bird should be fed on a good growing ration. About 3 weeks or a month before marketing, the capons can be put on a fattening ration.

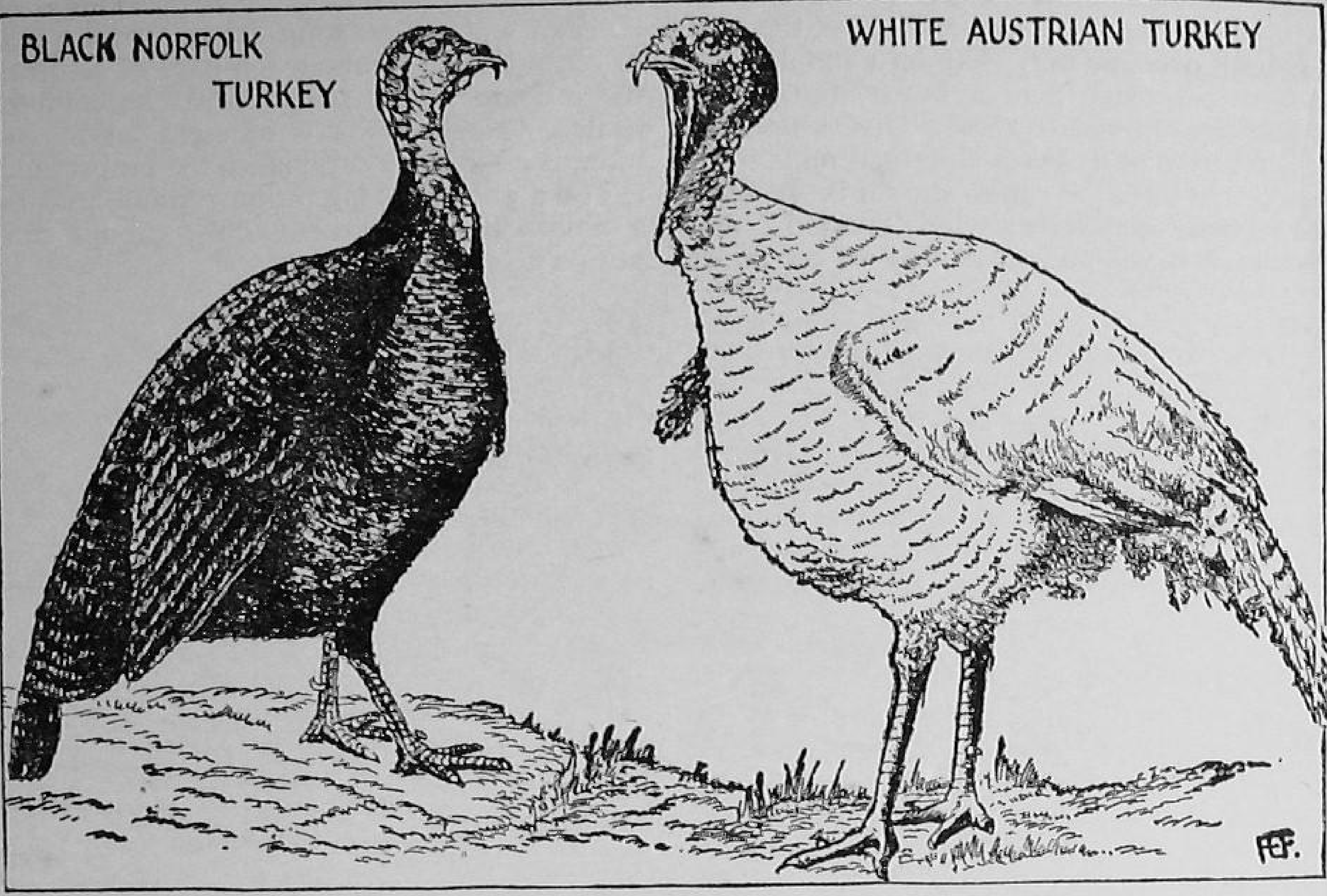


FIG. 27.—Two useful breeds.

TURKEYS, DUCKS AND GEESE

The various breeds. General management. Hatching, Rearing, Feeding, and marketing for the table. The laying duck. The Guinea Fowl.

TURKEYS.

Breeding of Turkeys.

UNLIKE other classes of poultry, with the possible exception of geese, turkeys are associated in the mind of the public with Christmas. One may look in vain for them during the rest of the year. Despite this, the breeding of turkeys has increased enormously in recent times (excluding the war period). Large numbers have always been imported every Christmas season. The demand is naturally for a large bird, but not so large as was customary some years ago. The bird now in favour is a poult weighing about 10 pounds with cocks scaling from 12 to 18 pounds.

Choice in Breeds.

There is not a large choice in breeds. The American Bronze was, and still is, a favourite where the largest birds are required. Then there is the Cambridge Bronze, the Black Norfolk and the White Turkey. All produce large birds with the exception of the Black Norfolk which meets the demand for the smaller frame. This last named breed does, however, have the finest quality flesh. Where cross-bred turkeys are preferred the American Bronze and the White may be crossed, and another excellent cross is that of the Bronze with the Black Norfolk.

Selection.

Careful selection of the breeding stock must be made and only healthy and well matured birds selected. Most breeders prefer them to be two or three years old, considering birds of this age to be the best for breeding. Others will use younger birds provided they have been hatched early and are well developed. Very large turkeys do not often make the best breeders; this especially applies in the case of the males, where heavy weights are a detriment to good mating. A young male scaling about 20 pounds is the ideal weight with the hens tipping the scales at fifteen or sixteen pounds.

One male should be mated to eight or perhaps ten females and mating should take place sometime in January.

Housing.

As regards housing, a large open shed will do. Perches should be at least two feet from the ground. In an ordinary fowl house, an adult turkey should have plenty of room, about 8 square feet of floor space.

Eggs should be looked for about March, and as turkey hens lay away if favourable opportunity occurs, a watch must be kept for these nesting

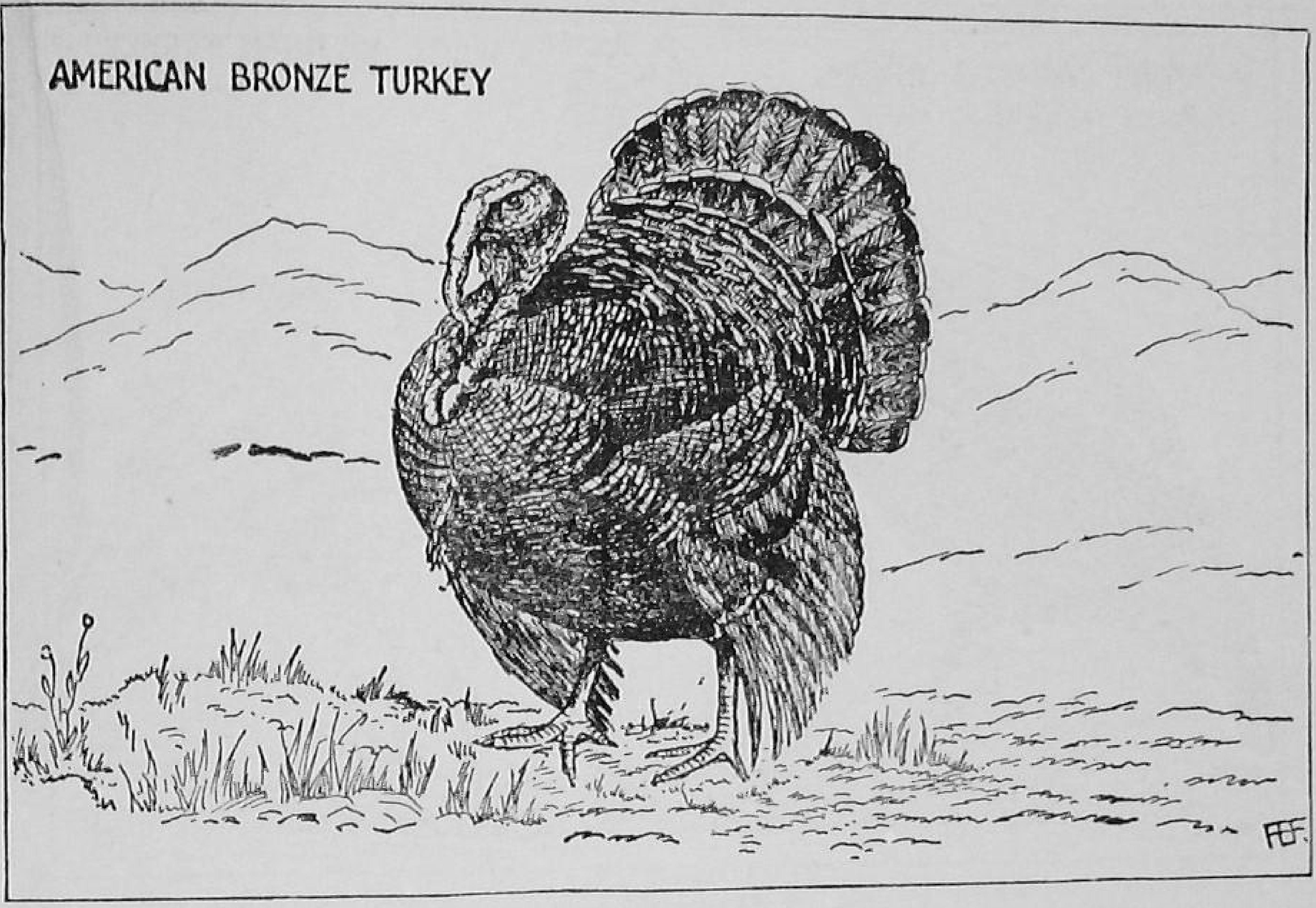


FIG. 28.—Produces large birds.

places. Nests should be provided to encourage the birds to lay in their home quarters.

Incubation.

Incubation takes 28 days, and hatching can be done either by natural or artificial methods. The turkey hen will sit on her eggs, but it is customary with natural hatching, to use a good size broody hen if available. When hatching in an incubator, the procedure is closely similar to that advised for hen eggs (see incubation). The temperature should be about 103 degrees F. but not above this. Turning may take place three times daily. In the case of turkey eggs, some people recommend a cooling for about 10 minutes a day during the last ten days of incubation. See plenty of moisture is provided, and it is advisable to sprinkle the eggs with luke warm water each day during the last week. Test about the eighth day for infertility. This is very necessary with the early batches, for should there be many infertile eggs it may be advisable to remove the male bird and feed him up for a day or two.

Rearing turkeys is not the difficult task often imagined. Where there are only a few to rear, large coops with a run attached may be used, and they may then be reared naturally by the broody hen. The runs can be removed after about a fortnight, and the youngsters will do without the hen when about six weeks old. When a couple of months old they will have outgrown the coops and should be housed and allowed to roost on boards raised about two feet from the floor. When large numbers of turkey chicks have to be reared, then the artificial method of brooding will have to be used. The ordinary adaptable hover will do for the purpose and units of 60 or 70 can be run together. Heat will be required for about six weeks, a little less when the weather gets warm. The temperature of the hover should be between 80 and 90 degrees F. during the first week, and should be gradually reduced afterwards. When intensively brooded, sun parlours similar to those used for other poultry stock are recommended to enable the turkey chicks to get the maximum amount of sun and fresh air. Where the young turkeys have access to a grass run they should be encouraged to use it as often as possible. The grass must be kept short. It should be remembered that turkey chicks need more room than ordinary chicks at all stages of their growth, and about double the floor space should be allowed for them when they are being reared intensively. When the young turkeys have "shot the red" (the face has reddened and the wattles have grown) they are considered past the danger stage in rearing. There is no best system of feeding. Wet or dry mash and grain, as preferred, or even pellet feeding, can be practised. The birds should not be fed at all the first day after hatching. Then for the first week they should be fed every two hours, sparsely at

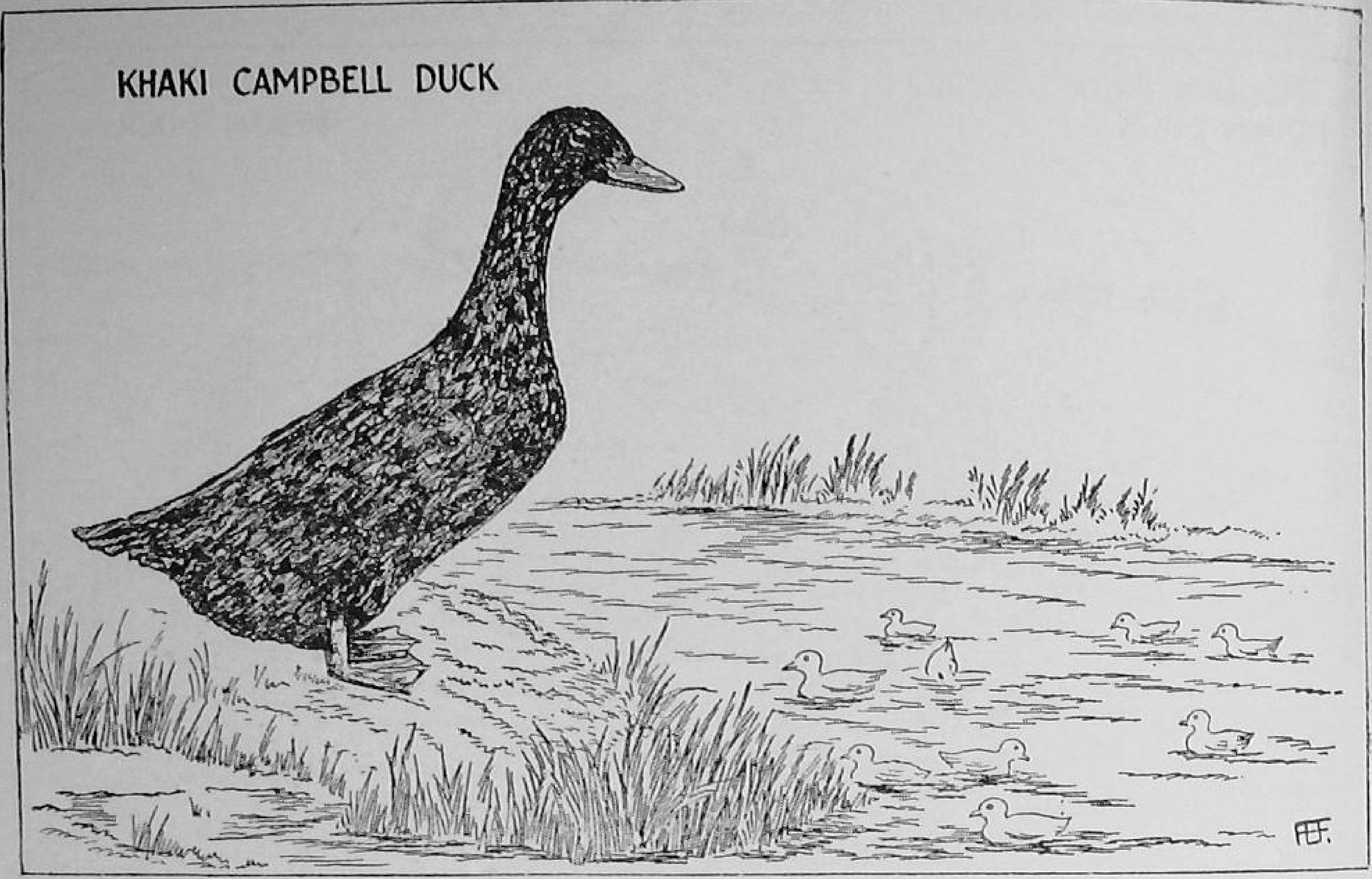


FIG. 29.—An excellent egg breed.

first and gradually increasing the amount. It used to be the practice, and probably still is where there are few birds, to rear them on a wet mash over which special care and some time is spent. The wet mash consists of hard boiled egg mixed with well soaked biscuit meal and finely chopped green stuff. Where there are many birds feeding is simplified by the use of mashes less elaborate. After the first week meals can be reduced to say four a day until the birds are some three months old, when they can be finally reduced to three a day.

Fattening.

On the question of fattening turkeys for the market, opinions differ as to whether they should be brought into pens, or left on range. About four weeks are allowed for the fattening, and at first three meals a day should be given, reducing to two towards the end of the fattening term. The best mixture is the old fatteners' favourite of Sussex Ground Oats and skimmed milk with the addition of fat during the last week. The birds should be given as much food as they will clean up quickly at each meal, any surplus being taken away. Some producers like to give a grain feed with this fattening mash and in that case it should be well soaked and fed in the afternoon, using the mash earlier in the day.

DUCKS.

Breeding for Laying.

Duck-keeping today falls into two separate categories: the birds are bred either for the table or for egg production. A great advance has been made in recent years in breeding for laying purposes. The keeping of ducks in large numbers, or those of the larger varieties for breeding purposes, is not very satisfactory on small holdings because they need ample range, and this is more likely to be available to the general farmer, who can allow them to roam over low lying pastures and along the hedgerows, where they will forage and get a great deal of the food they require. A pond or stream, whilst not being absolutely necessary, is an advantage. Small holders can of course keep ducks in small numbers in confined runs, and some people do this with good results, but costs of feeding in this case will be higher than under conditions of free range. There is an objection in some quarters to what is termed the strong taste of the duck's egg. This is largely a matter of fancy now, when ducks are kept under much better conditions than they were a few years ago. Some of the more modern breeds of ducks are wonderfully good layers, in some instances producing more eggs than laying pullets.

Shelter.

Ducks do not require elaborate housing, but they certainly need shelter of some kind. It is a mistake to think that they should not have such dry and clean housing as fowls. The writer once housed Khaki Campbell ducks in batches of 50 in sheds of the Lancashire Cabin type. These were erected in a spinney just above running

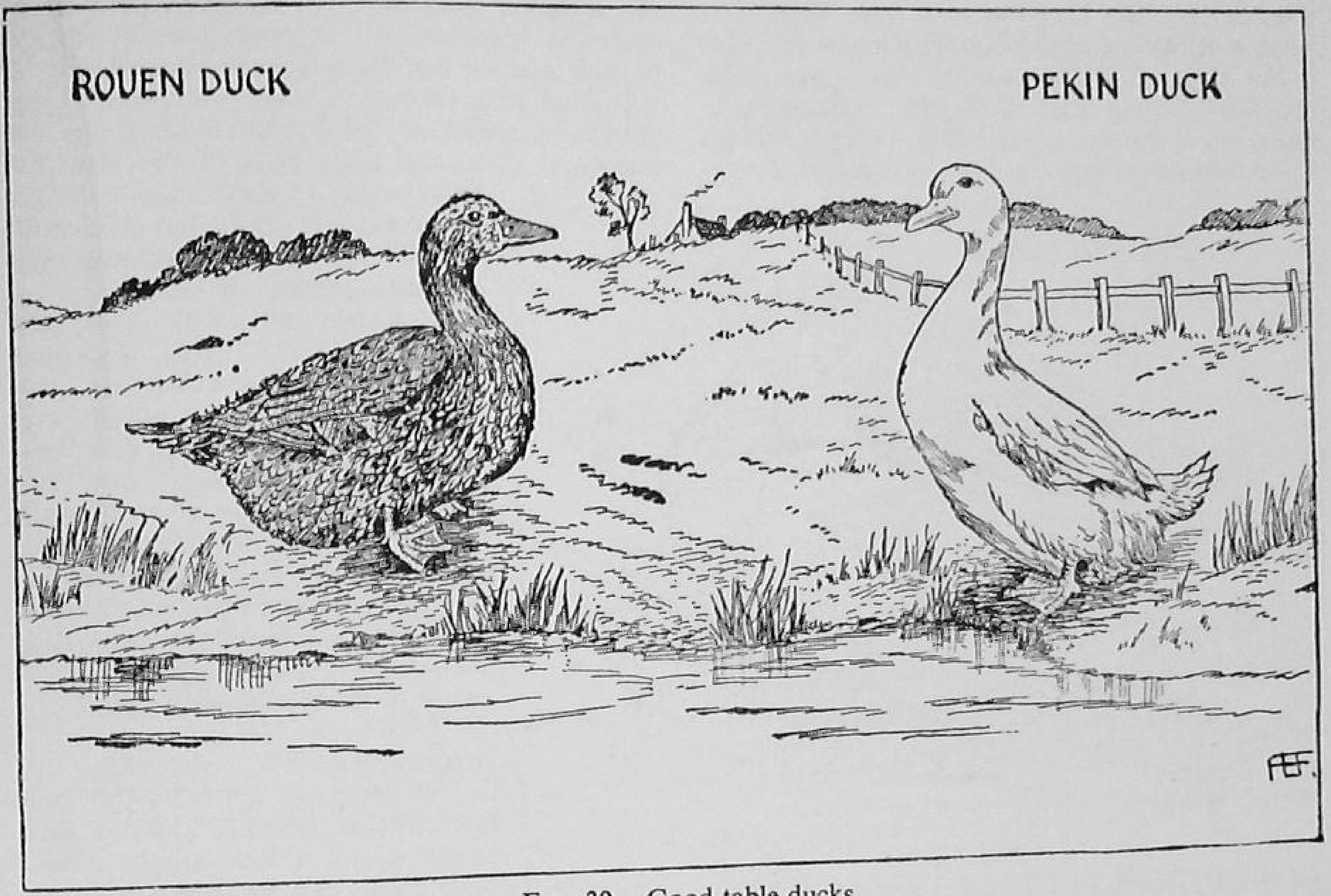


FIG. 30.—Good table ducks.

water. The floors of the cabins had a second slatted floor above them, in sections, to facilitate cleaning, and on this straw was spread. Forked over every day, the straw kept in fair condition and it was a good time before renewal was necessary. Plenty of air circulated through the cabins. To disturb them as little as possible, because of their very nervous character, the ducks were not fed inside. Attached to each house, was a wire run or feeding pen which could easily be opened after the birds had fed early in the day, and it could be used again when the ducks were fed on their return in the late afternoon. They were never let out before ten o'clock in the morning in order to get as many eggs laid as possible in the house, before the run was opened. Failure to carry out this precaution would have resulted in a visit having to be paid to water to reclaim the eggs laid there.

Table Ducklings.

For producing table ducklings, the best of the heavier breeds of ducks are the Aylesbury and the Pekin. The Aylesbury is the better for table qualities. It matures quickly. On the other hand it is not so good a layer as the Pekin. A cross between these two will give ducklings carrying white flesh of excellent quality at about ten weeks of age. Another breed, the Rouen duck, is a larger bird but grows more slowly taking three or four weeks longer to reach a marketable size.

For laying purposes the breeds to keep are the well known Khaki Campbell, and the White Runner. Probably the Khaki Campbell is the more popular.

Mating Up.

In mating up the breeds, the table stock should have one male to five females. With the laying stock one male bird to six females may be allowed, and even flock mating can be practised. The heavier ducks will be all the better if they have access to swimming water. The use of ducks under twelve months old for mating is not recommended. A vigorous young drake can be mated with the more mature ducks. Early mating will have to be undertaken if ducklings are required for the Spring and early Summer trade. The birds for mating should be selected early in the fall and mated up well before the eggs are wanted for hatching. Where eggs are required for table, then March and April are the best months for hatching. It is possible, where one does not wish to breed, to purchase day old ducklings, and they can be sexed if required. Duck eggs can be successfully incubated, but where numbers are only small, it is best to use a broody hen. Seldom are ducks used for the purpose. Nine or ten eggs are

usually sufficient for one hen, though a dozen Runner eggs can be given to a large bird. The treatment of eggs during hatching under broodies is the same as in the case of hen eggs. Some breeders, feeling that duck eggs require more moisture in the air surrounding the eggs, obtain this by watering the ground around the sitting coop

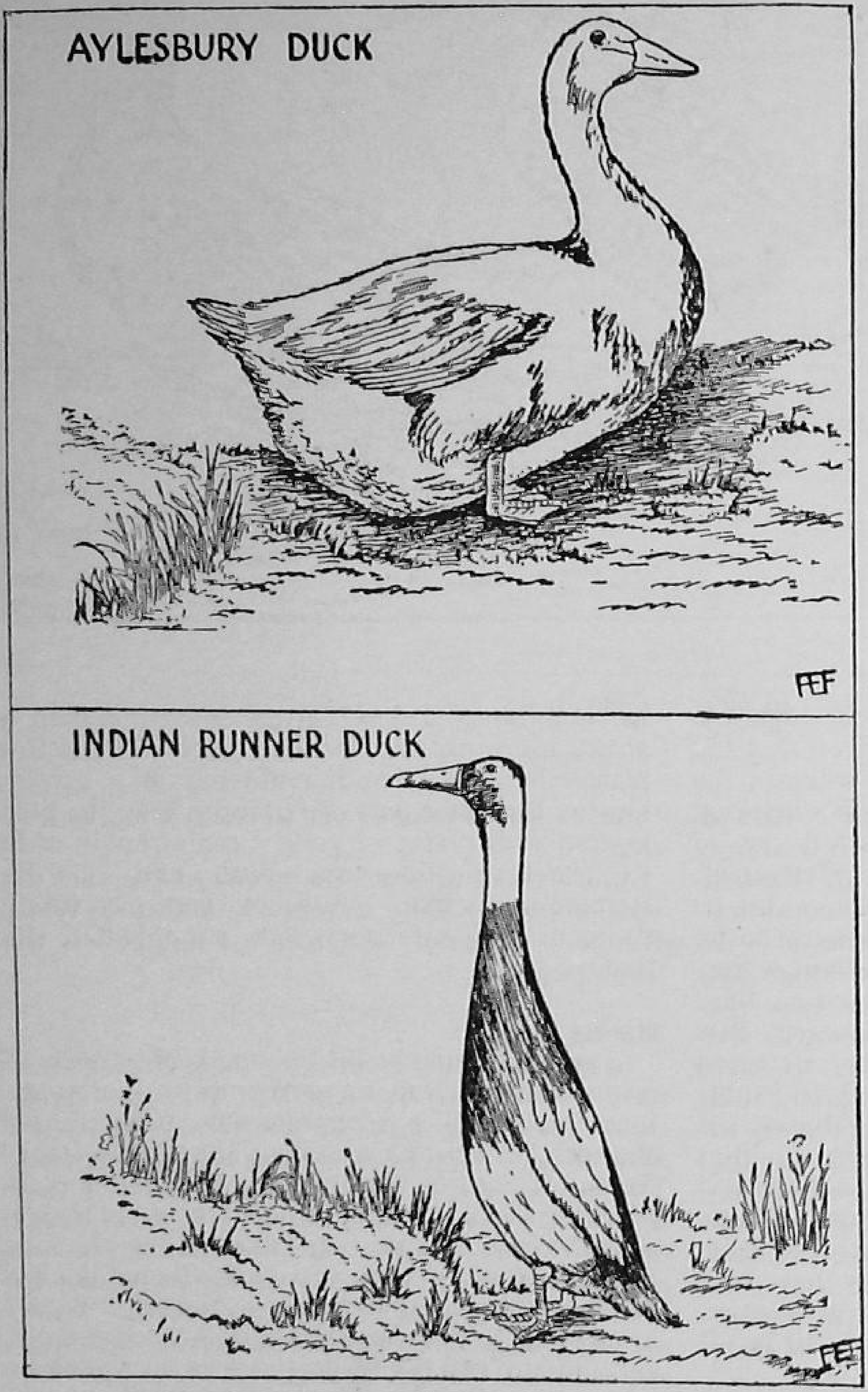


FIG. 31.—*Above.*—The old favourite for the table. *Below.*—A prolific layer.

every day with a little warm water. During the last week or ten days, particularly if there is an east wind blowing, or the weather is very dry, the eggs are sprinkled with warm water just before the hen returns to the nest. If incubators are used the temperature should be one degree less than for hen eggs, viz. 103 degrees F. The eggs should be turned three times daily, and during the last week or ten days should be cooled for about ten minutes each day. A liberal allowance of water is necessary all through the incubation period, and during the last week eggs should be sprinkled with lukewarm water each day. Eggs should be tested on the eighth or tenth day for infertiles, as in the early part of the year the percentage of these may be high. A second test about the eighteenth day will enable one to remove eggs containing dead embryos.

Ducklings are hardy birds, and rearing of both table ducklings and those intended for egg production can be done either with broody hens or artificial brooders. When the ducklings are hen hatched, it is well to allow them to remain with the hen for about three weeks. After this time several lots can be combined in one house. After the first few days grass runs should be made available. It is useful to provide a wind break.

Artificial Rearing.

The ordinary hover is the best for artificial rearing. Placed in a house about 6 feet square it will take about 50 ducklings comfortably. Special care must be taken to guard against vermin as rats are very partial to ducklings. The temperature for the first few days should be 85 degrees F., gradually reducing it each week until it is possible to dispense with it, between three and four weeks afterwards. When ducklings are being reared for the table, it is required to bring them on as early as possible, so as to be able to market them when they are about nine or ten weeks old, that is to say before they get their second coat of feathers. Therefore a big frame should be produced during the first weeks and feeding for flesh should be done in the later stages. The run of these ducklings should be curtailed during the last week or ten days before marketing. No swimming water should be allowed.

Rearing for Egg Production.

Rearing for egg production may follow the same lines as for table during the first few weeks. After finishing with heat, the ducklings may be accommodated in large roomy coops, being given a large run or their liberty. At about eight weeks the sexes should be separated. They are very nervous and react to anything out of the ordinary, so they must not be treated roughly. One can

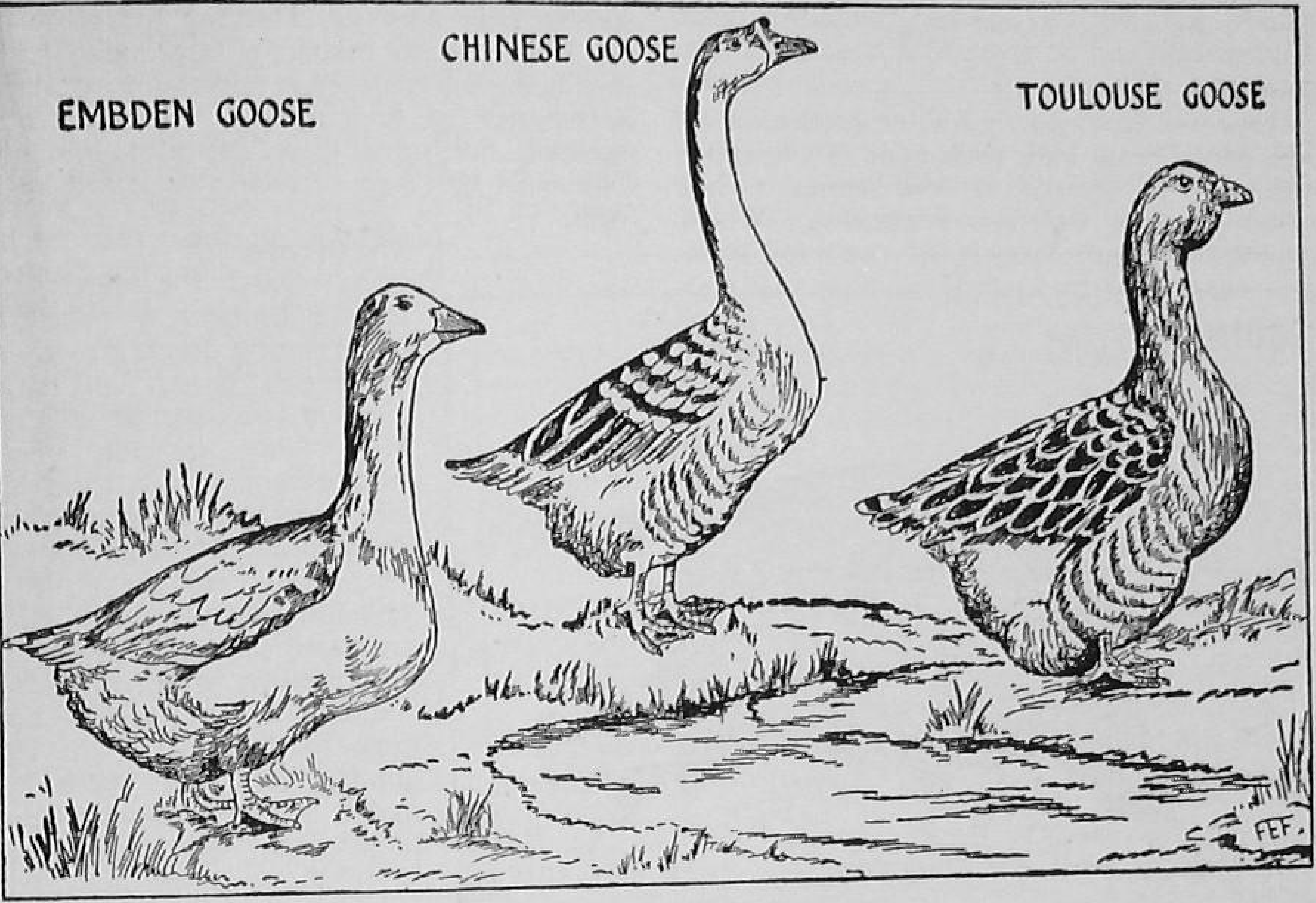


FIG. 32.—Three good types.

distinguish the sexes by getting them together. On rounding them up it will be noticed that the ducks make the familiar quacking whereas the drakes make a decided hiss or harsh shrieking noise. Any doubtful ones can be left out of account at first and be checked afterwards. When the sexes are separated the ducks can be given their liberty. Slow growth is desired in the case of ducks for laying. A few weeks before they are due to lay they should be housed in their permanent quarters, to give them time to settle down. The drakes on separation may be treated in the same way as that employed for table ducklings, for though not a table breed, the writer can testify to the excellent eating qualities of a Khaki Campbell drake after it has been suitably fattened. The treatment of any ducklings intended for future stock will be exactly the same in the brooding and rearing period as that given to the potential layers. They must be allowed free range after about five weeks, and will be all the better for access to swimming water.

Ducklings require feeding at frequent and regular intervals in the early days after hatching. Little and often should be the rule, and for this reason they should get five meals a day of a crumbly moist mash fed in shallow troughs. The number of meals can be reduced to four after the first week, and again to three when the ducklings are past a month old.

Fattening Ducklings.

In fattening ducklings for the market, three meals a day of a good fattening mash should be given, allowing the birds all they will eat in a reasonable time, and removing the surplus. During the latter part of fattening keep the birds littered with plenty of good clean straw in order to prevent soiling the flesh and feathers. Remember, clean white feathers, especially those of the Aylesbury, are a profitable side line.

Killing.

The ducklings should be starved for quite 24 hours before killing, so as to empty the crop and intestines. Killing is best done by dislocation of the neck, though this is less easy than in the case of fowls. If done properly death is instantaneous. Plucking should be done at once whilst the body is warm. Great care must be taken in the plucking since the skin and flesh of a well fattened duck is much more tender than that of a chicken, and tears more readily. The feet should be washed if dirty, and the bird put breast downwards on a shelf or table with a weighted board placed over the back. Where a lot of birds are being handled the ordinary shaping trough described elsewhere should be used. Never pack birds until they are properly cooled off. It should be remembered with table ducklings that they should be killed for market before the second lot of feathers begins to appear. Failure to market them then will result in the ducklings losing condition, and it will take another month or six weeks to get them into condition again.

GEESE.

Demand at Christmas.

Geese are kept entirely for the production of table birds, being most in demand at Christmas with a lesser demand at Michaelmas. They cannot be kept well in confinement. Whilst commercial poultry farmers will run a few geese to graze the grass in their chicken pens—and they make a good job of this—the place for keeping geese in any number is the general farm or a holding with facilities for grazing on common ground. Here they will find a good deal of their food. It is open to question whether geese should be allowed to range over good grass fields, but they can with profit be allowed to feed on the stubble after harvest. Housing for geese need not be a difficult matter, a large open fronted shed being sufficient, each bird requiring about 8 square feet of floor space. Perches are not required, but some litter should be provided. Care must be taken of course to guard against foxes.

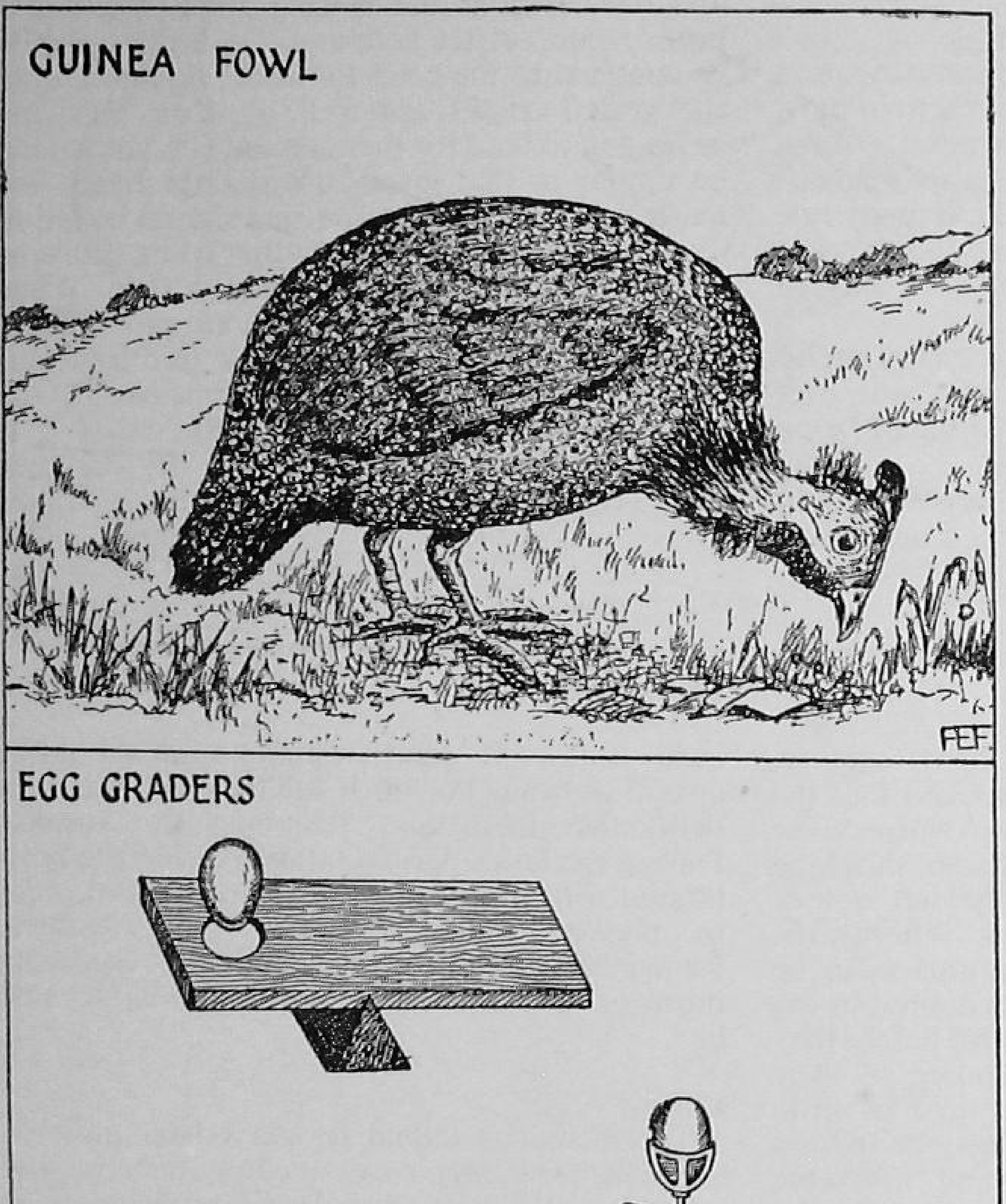


FIG. 33.

The Breeds.

As regards the breeds, there are the Embden (a pure white breed) and a quick grower, and the much larger and slower growing Toulouse, which is grey. Then there are the Chinese varieties, smaller birds and therefore more in demand with small households. The Chinese breed when ready for the table will scale some twelve pounds. Breeding geese should be about two years before being mated to a young gander. Half a dozen geese to the male is the usual number and they should be mated in the Autumn in order to get them settled in together before the early Spring hatching. Swimming water need not be provided for the breeding geese. Hatching is better done by broody hens giving four or five eggs to one hen. If the geese which go broody at times are allowed to sit in the early season, the chances are that they will not lay another batch of eggs for some good time. Should there be a lot of goose eggs to hatch and enough broodies are not available then resource must be had to the incubator, and in that case the same routine will be carried out as advised for hatching duck eggs.

Goslings.

Goslings are the easiest of all birds to rear, and the ordinary hover as advised for brooding ducks can be used. This need not be in use for more than one to two weeks. If the goslings are being brought along by the broody hen, then they should be allowed to stay with the hen for three or four weeks. They grow very quickly and must have plenty of room. Rearing can be done as recommended for the other water fowl. Goslings may be fed in a manner similar to that used for ducklings. After a time, if they can have access to grass, two or three light feeds daily will be all that is necessary. Geese should be fattened for about three weeks, and if they are confined at all it should be in a roomy shed with

an open front, allowing about ten square feet per bird. The ration should be of a good substantial nature and may include, as well as middlings, barley meal and maize meal, a good allowance of steamed potatoes.

Guinea Fowls.

Characteristics and Management.

A book on poultry should make some mention of Guinea Fowls, although one sees them in most places simply for ornamental purposes. In a farmyard they prove very good "watch dogs." In spring the guinea fowls will make a ready sale when the ordinary fowl is in short supply, and it is surprising that they are not seen on the market at other times of the year.

Housing is not required for them. They prefer to roost in the trees, from whence they will utter loud cries at the approach of any human being or animal.

The most common colours are speckled, and there are also whites. Both sexes are alike in colour and the male bird mates with about three females. It is usual to leave them to make their own nests in a position they fancy, and a look out should be kept to locate these. Eggs are dark brown marked with spots of a lighter colour. They are looked on somewhat as a luxury and they make a good sale. Hatching takes 28 days, and the hatching and rearing are best left to a broody hen. After hatching, the broody should be confined to the coop for about a month, until the young chicks are well on their legs and beginning to fend for themselves. Feeding should be similar to that given to ordinary chicks, wet mash being preferable, and this should be fed to them five times a day for the first week, reducing gradually to four and three meals a day. When the chicks are ready to range they should have their liberty and will require little feeding. This can be given to them when they come back to the farmyard at night. In the early stages it is necessary to keep the youngsters dry, as they react very quickly to damp conditions.

MARKETS AND MARKETING

Wholesale and Retail markets. The best methods of marketing. Packing Stations for eggs and poultry.

Proper Marketing.

Good marketing is essential for a successful business. One must of course provide just what the public wants to purchase, but having done this, having successfully surmounted all the hazards associated with production, what a pity it is to fail at the last stage, by careless marketing! Yet, it is at this point that we, in this country, have lagged behind the foreigner. There are now signs of much improvement in this direction. The authorities concerned, recognizing the importance of proper marketing, have done much to encourage ways and means to this end. The grading of produce for size and quality is advised and practised, proper packages for different classes of goods are recommended, and market requirements for different seasons of the year are announced.

Stations for Table Poultry.

An innovation in the poultry world that came to the fore a few years ago, was the establishment of fattening, killing, grading, and marketing stations for table poultry. These stations could accept well-grown, unfattened birds, and fatten kill and market them for a set fee, paying the producer the market price received for his birds.

In the same way they could take fattened birds and simply charge for killing, plucking and marketing. Some stations would purchase the birds outright from the producer. This was a very welcome help for a producer who found it difficult to get a good fattener, or could not find the necessary labour to kill and pluck his birds. It is possible these stations may go ahead when things settle down again, and it may become compulsory for all producers to sell through them in the interests of good marketing.

Packing Stations.

Packing stations for the reception of new laid eggs have been established. Eggs from the farms are collected by vans and brought to the packing station. Here they are cleaned if necessary (though this should be done by the producer himself), candled for freshness, graded for quality and size, and then packed in the proper cases for shops, hotels, etc. The packing stations pay the producer the price received for the eggs less a charge per dozen to cover the overhead expenses of the station. There is much to be said in favour of these stations, which up to 1939 were on a voluntary basis. Now all eggs have to be sent to them, with the exception of those from very small producers. Whether this compulsory measure will continue is not known, but it would be a misfortune to go back to the "anything will do" style of marketing of the past. However eggs are sold, they should be marketed fresh and clean. No eggs from "stolen" nests, i.e. eggs laid away from home in hedgerows and the like, should be packed with those of known age. There is a risk of them being bad, and a bad egg will naturally mean a dissatisfied, and probably a lost, customer. If the producer is serving his own private customers, he should grade his eggs for size in the same way as the packing station.

Marketing Table Poultry.

There are various methods of marketing table poultry. The man in a small way of business will look for private customers to whom he will retail his birds. Where the producer has a large regular output throughout the year, the private customer is not necessarily the best proposition. However many customers the producer may have, he is bound to have some birds left on his hands at times, which he will have to sell as best he may, and he will be lucky if he is always able to place these in a shop at the price he desires. Large consignments can be, and are, marketed through the hotels and large catering establishments, but here again is the danger of supplies not being wanted at certain times. The writer, who marketed birds regularly over many years, found the large wholesale markets a very satisfactory outlet for his produce. However the quantities varied the birds were always taken without hesitation and a cheque in payment came back promptly in the course of a day or two.

Grading Chickens.

Chickens should of course be graded for market, that is they should be of as near a size as possible in each package. Especially should this be the case in the non-returnable package, and the reason for this is obvious. If the packages can always be depended on to contain exactly what the invoice says, and nothing else, then confidence is established between producer and distributor, and again between distributor and purchaser. As a result, a great saving in labour, time, and temper is effected. The purchaser can buy on the invoice with confidence and need only look at one sample package, or not even bother about that.

The writer was once told at Smithfield, by a large distributor, that three quarters of the produce handled by him came from abroad, and was dealt with by one quarter of his staff, leaving the one quarter of English produce for three quarters of his staff to handle.

Continental Efficiency.

Marketing has been reduced to a fine art on the Continent where it is done under government supervision. Producers would do well to make it their business to visit the large wholesale markets. It is an object lesson and it will pay them to do so. The distributors, though busy

men, are always ready to find the time to discuss the market and to give advice on marketing and market requirements.

If the producer arrives in the market early enough, he will probably see, or would have seen before the war, scores of packages stacked one on top of the other, marked with a foreign label, and the contents described in plain terms. In will come a buyer with a large order, look at the labels, and place his order, departing, in many instances, without having one package opened for inspection. It will be a great day for us when we can market in like manner. Birds that still go to market in the Sussex ped, have all to be turned out, graded and repacked before sale, for though one will often find a layer of good birds on top, some slightly poorer ones will be found in the next row, and so on, until in the bottom row are found the third rate birds. It is probably forgotten that when the ped is emptied these poor birds will come out on top!

The willingness to take any varying quantity of chickens at unstated times, together with prompt payments for consignments, makes wholesale marketing much more attractive than the uncertainties of retail trading despite the increased prices received from the latter.

Local Markets.

All types of poultry farm will at some time or other have old hens and cocks to dispose of. Birds finished with as breeders, pullets that have ended their laying season, and whose record does not justify their retention for another year, as well as hens that have gone through two seasons and are not quite right for the breeding pens: all these will have to go. There is a good market for this class of fowl at certain times of the year, and for the same trade, the birds can be sold alive in the local markets. The birds must, however, be well fleshed. Thin and out-of-condition birds will make next to nothing. Enquiries should be made at the markets as to when the birds will be required.

Ducklings for the table must be marketed when about ten weeks old, or they will soon begin to go back. Where there are not many to dispose of, probably it is better to sell to private customers or the local poultry shops. If large numbers are to be sold, them the markets will have to be the channels of disposal.

Geese in the same way can be marketed privately if not in large numbers. Plucking geese has to be carefully done. As with ducks, it requires more care than plucking fowls, and for that reason many producers like to dispose of their birds alive if possible.

Turkeys are often bespoken by customers some time before Christmas and a good many of them can be disposed of in this way to private customers. There is usually a big demand for turkeys of all sizes right up to Christmas Eve, after which it practically ceases. Unsettled mild weather will cause prices to fluctuate rapidly as will the arrival of heavy imported consignments. Local markets will take turkeys alive, but the wholesale markets will want them killed and plucked. If large numbers are to be disposed of, they should be carefully graded when packing for market.

A Marketable Sideline.

Poultry Manure is a marketable sideline from all types of poultry holdings. It is not out of place to mention it here. True, it does not make the ready sale it should, probably because little has been heard of it. As a fertilizer it should be especially useful to market gardeners and nurserymen. Where birds are on range, the manure cannot be collected, but where they are in fattening cages, it can be gathered from the floor, and in the laying or breeding houses, from the dropping boards. It should not be kept in the open, where it will rapidly deteriorate, but should be stored under cover. Some people prefer to mix it with earth in the proportion of two parts poultry manure to one of earth. If it is possible to spread it on trays in a shed to dry, so much the better. In addition to nitrogen poultry manure contains phosphates and potash. It is said that a growing bird voids about 25 lb. in six months, and that about thirty adult birds will make one ton of manure in a year.

Feathers are quite a profitable sideline on a table poultry plant and buyers will take them at so much a pound. White feathers always make a higher price than the coloured ones, so they should be kept apart. For purposes of sale, wing and tail feathers must not be put in with the others. Horticulturalists will sometimes take the latter to rot down, or plough in for manure. The feathers for sale should be kept clean, put into clean sacks and hung up out of the way of mice, to dry. When a good quantity is ready for marketing, buyers will often call and collect the feathers, paying for them on the spot. It is estimated that the feathers from 100 average birds (apart from the wing and tail feathers) will amount to 25 lb.

Various Sales.

One hardly considers the sale of hatching eggs, day-old chicks, and growing and adult stock, as coming under the label of marketing. As, however, holdings are in existence whose sole object is the sale of this class of stock, their disposal may well be considered here. Breeding establishments have their own conditions which govern the sale of hatching eggs; these are usually sold in dozens, 25–50 or 100 and over. It is the rule to replace infertiles once, where dozens are sold, but where 15 eggs to the setting are supplied, then no replacements are made. It is usual to ask for the return of the infertiles before replacement. Proper egg boxes should be used for the despatch of hatching eggs, as in

most cases they will be travelling by rail and the railway companies will not usually accept them if they are improperly or carelessly packed. Whilst eggs will travel well in boxes made for the purpose, some people use sawdust as packing to made doubly sure.

Day-old Chicks.

Day-old chicks are sold straight from the incubator by breeding farms and hatcheries. It is usual to offer to replace any dying on rail if they are returned at once to the vendor. These day-olds are also packed in special boxes, usually in dozen or two dozen lots. The boxes are lined with hay in order to keep the chicks snug in transit.

The sale of day-olds and hatching eggs is confined in great measure to the early spring months, when the weather may be treacherous, hence the care that should be taken in their marketing. Growing stock on the other hand will usually be disposed of in the late spring and summer months. Care must be taken in the sale of birds at eight weeks or three months, or even over, to see that they are not overcrowded in their hampers. If they have far to travel they should be fed and watered before despatch.

Stock cockerels and pullets, or hens for breeding, are generally required for Autumn. It is usual to send these on approval, a stipulation that they be returned in two or three days if not acceptable, being made.

FEEDING

The importance of correct feeding. Requirements of different kinds of stock. Different classes of feeding stuffs. Proteins, Carbohydrates, Fats, Vitamins. How to make up a balanced ration. Starch equivalent. Food units. Notes on various feeding stuffs. Feeding methods. The merits of wet-mash compared with dry-mash feeding. Grain feeding. Specimen rations for all kinds of stock.

Correct Feeding.

CORRECT feeding is of the utmost importance in good poultry keeping. If a year's expenditure on the holding is examined, it will be found that the costs of the feeding stuffs during the year is the largest item. So, however good the stock, however careful the methods of running the place, injudicious, extravagant, or wasteful feeding, can easily be the means of turning a profit into a loss.

Problems of Nutrition.

The poultry farmer should therefore have a sound working knowledge of the problems of nutrition. The various feeding stuffs in use should be recognizable at a glance, and it should be possible to pick out faulty samples. True, one can always purchase proprietary mashes of excellent quality from firms of reputation; and there is a lot to be said for doing this. A good deal of time is saved where food arrives ready prepared for the different classes of stock, and mixing has not to be done on the holding. Proper facilities are not always available on the farm for the thorough mixing which is necessary when mashes are made up. To do this work properly on a large holding is a lengthy job, unless a mixing machine is ready to hand. A good many proprietary mashes on the market are well known and have given satisfaction through the years. Granted all this, the keen poultryman should be in a position to mix his own ingredients if necessary, knowing what the exact proportions should be for young chicks, growing, laying, breeding and fattening stock, and why such proportions are required.

Food is required for a number of purposes (*a*) to keep the fowl's body in a healthy condition, (*b*) to produce growth, (*c*) to provide for the production of eggs, and (*d*) to make muscle and form fat in the table bird.

The food required to keep the bird healthy and to repair waste is known as the maintenance ration. If this is the only food given, few eggs will be produced and no additional flesh. To obtain eggs and produce more flesh extra food will have to be supplied, and this which is called a production ration, must of course be of a suitable character.

Likewise, all young stock requires a certain daily amount of food for growth, in addition to that necessary for maintenance; for growth can only be obtained, when the ration fed is in excess of the amount required for the upkeep of the body.

For all these purposes, growth, egg production, and fattening, the right kinds of food in their proper proportions, must be fed in the productive portion of the ration.

Foodstuffs are classed as nitrogenous and non-nitrogenous. The former contain nitrogen in the shape of proteins and amides, and the latter contain fats and carbohydrates.

The nutritive value of a feeding stuff is decided by the presence or absence of any of the following nutrients:—(1) Proteins (including amides); (2) Carbohydrates (starch, sugar, fibre, etc.); (3) Fats and Oils; (4) Water; (5) Minerals; (6) Accessory food substances (i.e. vitamins).

Flesh Formers.

PROTEINS or flesh formers are found in fish-meal, meat-meal, milk, soya beans, peas, and beans, and in a lesser degree in grains and their by-products. They are very important food constituents, and are necessary for all forms of production and for maintenance. Typically the proteins contain the elements carbon, hydrogen, oxygen, nitrogen, sulphur, and sometimes phosphorus.

All proteins are made up of what is known as amino acids. There are a good many of these, though no protein is known to include all of them. The feeding value of a protein depends upon the kind and amount of amino acids it contains. Some are more important than others. Three known as lysine, cystine, and tryptophane are required in fairly large quantities in food given to young stock if normal growth is to be maintained.

During digestion, proteins are split up into their constituent amino acids. These enter the blood stream through the walls of the gut, and are used for the repair or growth of the tissues. Where a protein is fed which supplies an excess of amino acids required by the tissues, the excess is carried to the liver, where it is converted into uric acid, and eliminated by the kidneys. This over-feeding of proteins if persisted in, can be a danger to the health of the birds to say nothing of the waste of money entailed in feeding expensive protein foods in excess of requirements. It will thus be seen how very important it is to feed fowls with a ration containing different kinds of protein, so as to avoid waste of the amino acids, and to make sure all the essential kinds are present, so as to obtain maximum egg production or growth. The amount of protein needed in a ration, will of course vary with the class of stock being fed. For about a week before hatching, a chick has remains of the yolk of the egg in its body, and it will draw on this for its protein requirements. From a week to the end of brooding, i.e. up to eight weeks, fairly large amounts of protein will be necessary in the food,

after which time the amount required diminishes. As laying is about to commence the protein requirements will increase again.

Sources of Energy.

CARBOHYDRATES are a class of substances composed of carbon, hydrogen and oxygen, the two latter being always in the same ratio, of two to one, as they are in water. Carbohydrates act as sources of energy to the body, and the excess is generally stored in the body as fat. They are cheaper to buy than fats, the common ones being starch, sugar and cellulose. Foods rich in carbohydrates include maize, rice, wheat, barley, oats and potatoes. When laying hens are fed with foods rich in starch, they become too fat, and the output of eggs suffers.

FATS AND OILS are energy formers like carbohydrates but belong to the group of chemical compounds called "esters." They differ from proteins in that they contain only three chemical elements, carbon, hydrogen and oxygen. Fats and oils when acted upon by the digestive ferments, are converted into substances called fatty acids and glycerine. Fats are a source of supply of energy to the body, one pound of fat being equal to about 2¼ lbs. of carbohydrates.

While, on the one hand protein may, when fed in excess of requirements, transform the surplus into energy thus replacing carbohydrates, neither fats nor carbohydrates can replace protein.

Importance of Water.

WATER, is of course, just as necessary for life as solid food is, and animals deprived of it will die in a very short time. It is interesting to note in this respect, that the egg is 68 per cent water and the body of the hen 58 per cent water. The importance of a constant and good supply of fresh water can therefore be appreciated. All water containers should be cleansed at frequent intervals. In the winter, when heavy frosts may be expected, they should be emptied every night. If during excessive cold some attempt is made to provide the birds with water with the chill off, the trouble taken will be reflected in the egg yield which will not sustain such a big drop as may occur if the water is very cold.

Mineral Substances.

MINERALS are just as necessary in a ration as other feeding stuffs. The bones of the bird's body are composed largely of mineral substances, calcium phosphate and calcium carbonate. Egg shells contain about 90 per cent of lime or calcium carbonate. These mineral substances are to a great extent supplied by the ordinary feeding stuffs, but special provision has to be made in some cases to meet deficiencies by feeding mineral supplements. Calcium for bone and egg shell is provided in oyster shell, limestone grit, or ground limestone. Sodium and chlorine for health and production are given in common salt, and phosphorus for bone in fish or bone-meal. Grass and green foods are rich in minerals, hence the advantage of a good grass range.

ACCESSORY FOOD SUBSTANCES—VITAMINS.

Vitamins.

It is only in comparatively recent years that research workers have found out that in addition to the proteins, carbohydrates, fats, and minerals contained in feeding stuffs, there is also a number of accessory food factors, necessary for growth and health. These accessory food factors only exist in small quantities, but are sufficient for the purpose stated, and are known as Vitamins. Lack of vitamins in the ration will lead to what are known as "deficiency diseases," and whilst this is not likely to occur with poultry on free range, it is necessary where they are kept in confinement, to make certain that vitamins are present in adequate amounts in the diet.

Vitamin A is the growth vitamin. This is necessary for normal growth and maintenance of health. It is found in yellow (not white) maize and alfalfa meal. Cod liver oil and halibut oil are also rich in this vitamin. Lack of Vitamin A will stop the birds growing and they will develop a most unhealthy appearance, rendering them liable to nutritional roup.

Vitamin B is required for general health. It is present in all grains, the commonly used feeding stuffs, and in green food. Yeast is rich in Vitamin B. Lack of the vitamin is shewn by the condition of the eyes, and causes what is known as polyneuritis (a nervous disorder) in poultry.

Vitamin C does not play an important part in poultry feeding. The lack of it causes what is known as scurvy, a disease to which poultry are not susceptible.

Vitamin D is the most important vitamin from the poultry point of view. It is essential for mineral assimilation and without it the development of the bones in chicks and the production of egg shell in laying birds is impossible. Lack of it, or insufficient quantities, causes leg weakness or rickets in chickens. There are three methods of providing Vitamin D: by means of Cod Liver Oil, by providing the birds with ample sunshine or by irradiating them with ultra violet light. Where birds are on range Vitamin D will be obtained from the sunlight. When hens or chicks are kept intensively the Vitamin should be added to the ration, for it must be remembered that sunlight which passes through ordinary glass is of no value for the purpose—the ultra violet light can only pass through special glass. The Vitamin D is therefore supplied through Cod Liver Oil which is rich in this respect. One per cent is sufficient in most cases. In practice it is also found advisable to add Cod Liver Oil to the ration of the breeding birds and growing birds on range, during the winter months. Chickens will not suffer from the lack of this

vitamin during the first six days of their life because the egg yolk in the chicks body, when hatched, contains enough Vitamin D for that time. Afterwards when the chicks are about ten days old, lack of the vitamin will result in the chicks being unsteady on their legs; and eventually they will be unable to stand at all, and will die. With laying birds egg production will be low and the eggs will be thin or soft shelled.

Vitamin E is found in whole grains and green plants. The lack of it will cause birds to become sterile. Where breeding birds are on grass range and are fed properly, there need be no trouble in this respect.

Balanced Ration.

In making up rations, the poultryman, whilst taking account of the composition of the foods, should know how to make a balanced ration. This is a ration in which a certain proportion exists between proteins and the energy producers, i.e. the fats and carbohydrates. This proportion is known as the albuminoid or nutritive ratio of the food, and will be alterable for different classes of stock, chickens, growing stock, laying or fattening birds; and the food whilst having the same ingredients, will require them in different proportion.

In working out the albuminoid ratio, the following method is adopted:—One pound of fat is equal in energy to approximately 2¼ pounds of carbohydrates, so the fat in the ration is multiplied by 2¼ and the result is added to the carbohydrates. The sum of the two is then divided by the amount of the protein which gives the albuminoid ratio.

$$\frac{\text{Carbohydrates} + (\text{fats} \times 2\tfrac{1}{4})}{\text{Protein}} = \text{Albuminoid Ratio.}$$

In actual practice it has been found that the albuminoid ratio for various classes of poultry stock should be:—

For laying Stock—1 part protein to 4½ parts energy producing material (fats × 2¼) + carbohydrates, or

1 to 4½
For Fattening Stock—1 to 6 or 7.
For Chicks to eight weeks—1 to 4¼.
For Growers—1 to 7.

When making up a ration, should it be found that the albuminoid ratio is too wide (containing too much carbohydrate and fat) a feeding stuff having a high percentage of carbohydrates should be reduced, and one with a narrower albuminoid ratio (containing a larger proportion of protein) substituted. Correspondingly, if it is found that the albuminoid ration is too narrow, a feeding stuff or feeding stuffs with narrow albuminoid ratio should be reduced in quantity, and others with wider ratios substituted.

In the accompanying Table the only food stuffs mentioned are those the poultryman is likely to come across in his work. It will also be seen that only the digestible percentages of the various feeding stuffs are given, it being considered that these are the actual figures one will want to use in making up a ration.

Here is a ration. If reference is made to the Table, the figures can be followed.

MASH FOR LAYING HENS (1).

	Protein	Fats	Carbo-hydrates
8 lb. Bran	·84	·22	3·04
2 lb. Maize-Meal	·14	·09	1·36
1 lb. Middlings	·13	·04	·45
1 lb. Fish-Meal	·47	·04	—
12 lb.	1·58	·39	4·85

GRAIN FEED.

	Protein	Fats	Carbo-hydrates
1 lb. Wheat	·09	·01	·65
1 lb. Oats	·08	·04	·44
1 lb. Maize	·07	·04	·68
3 lb.	·24	·09	1·77
1 lb. Mash	·131	·032	·404
1 lb. Corn	·080	·030	·590
	·211	·062	·994

ALBUMINOID RATIO OF THE RATION.

1 to [(62 × 2·25) + 994)] ÷ 211 =
1 to 1133·5 ÷ 211 =
1 to 5·37 Albuminoid Ratio.

This ration, working out at one part protein to 5·37 parts of carbohydrates plus fats, is too high in energy-producing feeding stuffs. What is wanted is something in the proportion of 1 to 4½. We must therefore take that part of the mash which is highest in carbohydrates and reduce the quantity, and at the same time increase another feeding stuff carrying more protein. If the Table be examined, it will be seen that the maize, with 68 per cent digestible carbohydrates, had better be reduced, and the fish-meal increased because that is the food carrying the highest protein content in this mash, viz. 47 per cent.

MASH FOR LAYING HENS (2).

	Protein	Fats	Carbo-hydrates
8 lb. Bran	·84	·22	3·04
1 lb. Maize Meal	·07	·04	·68
1 lb. Middlings	·13	·04	·45
2 lb. Fish Meal	·94	·08	—
12 lb.	1·98	·38	4·17

GRAIN FEED

	Protein	Fats	Carbo-hydrates
1 lb. Wheat	·09	·01	·65
1 lb. Oats	·08	·04	·44
1 lb. Maize	·07	·04	·68
3 lb.	·24	·09	1·77
1 lb. Mash	·165	·031	·347
1 lb. Grain	·080	·030	·590
	·245	·061	·937

ALBUMINOID RATIO OF THE RATION.
1 to [(61 − 2·25) + 937)] ÷ 245 =
1 to 1074·25 ÷ 245 =
1 to 4·38—Albuminoid Ratio.

Here by decreasing the maize one part and increasing the fish meal one part, we have a properly balanced ration for laying hens. Assuming that EQUAL quantities of the mash (dry) and grain mixture are fed to the birds each day, the albuminoid or nutritive ratio will not be altered, whatever weight of food is given.

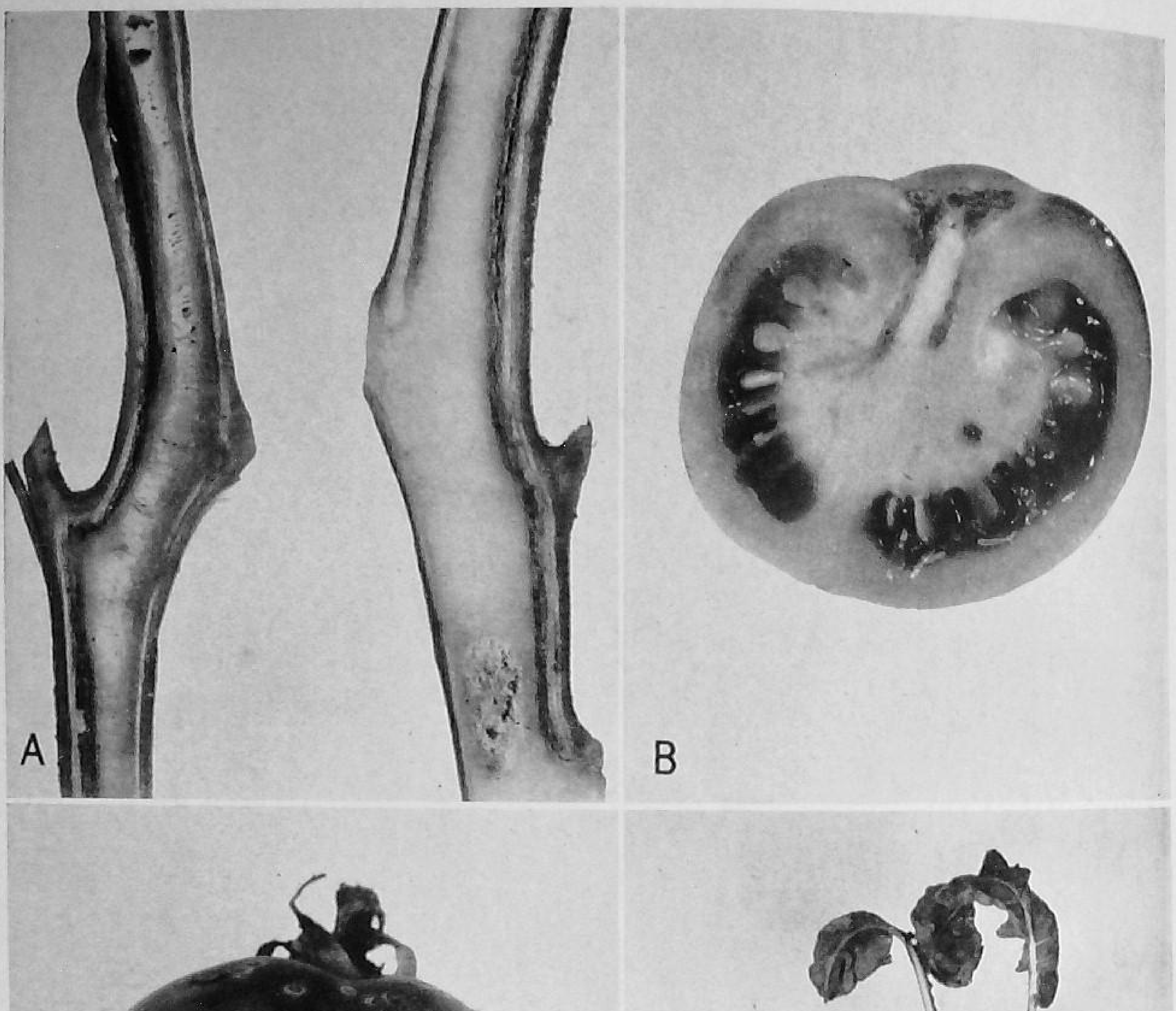
Whilst it is necessary for poultry rations to have a proper albuminoid ratio, it is also important that other factors should be taken into account. It is quite easy to make up a balanced ration from ingredients quite unsuitable for poultry. The vitamin content and the minerals must be noted. It is useless to give feeding stuffs which the birds cannot easily digest. From experiments carried out, it has been found out that the digestion of poultry is similar to that of other animals, except that very little fibre can be digested. Fibre should therefore be fed only in small quantities, not more than 6 to 8 per cent of the ration. It is also said that animal foods are easier of digestion than vegetable foods.

NOTES ON THE COMPOSITION OF SOME OF THE COMMON POULTRY FEEDING STUFFS
(COMPILED FROM VARIOUS SOURCES)

	Dry Matter	Digestible Percentage			Fibre	Ash	Nutritive Ratio 1 to
		Protein	Carbo-Hydrates	Fats			
Alfalfa Meal	89·3	9·2	22·0	·9	31·0	8·4	2·0
Barley	85·1	6·5	62·2	1·2	4·5	2·6	10·0
Beans	86·0	19·0	48·0	1·25	7·0	4·5	2·7
Biscuit Meal	90·6	12·5	68·5	0·6	0·3	2·7	6·0
Brewer's Grains: (Wet).	24·0	3·75	10·0	1·25	5·0	0·25	3·4
Brewer's Grains: (Dry) .	91 0	13·5	34·0	5·5	17·0	5·0	3·5
Buttermilk	9·9	3·0	5·4	1·0	—	[illegible]·5	2·6
Cabbage	15·0	1·5	7·0	0·5	2·0	2·75	5·4
Fish Meal	87·0	47·0	—	4·0	—	26·0	0·2
Earth Nut Cake Meal .	90·0	41·0	21·0	7·0	6·0	5·5	0·9
Maize and Maize Meal .	89·0	7·0	68·0	4·5	2·0	1·5	11·4
Milk (whole)	12·5	3·25	4·75	3·75	—	0·5	4·1
,, (dried skim)	89·8	29·6	48·8	0·3	—	7·9	2·0
,, (wet ,,) .	9·5	3·75	4·5	0·75	—	0·75	1·9
,, (separated) .	9·0	3·5	5·0	0·1	—	0·15	1·5
Maize Germ Meal	89·0	9·0	51·0	11·0	4·0	4·0	8·5

Above : SELECTION FOR BREEDING : HANDLING THE BIRDS
Farmer & Stockbreeder Photograph. Courtesy: Nackington Farms

Below: OVERSEAS VISITORS TO A MODERN FARM. A SWEDISH PARTY AT NACKINGTON FARMS
Courtesy: Nackington Farms



Photos : H. H. Glasscock

A—C. BACTERIAL CANKER OF TOMATO

A. SPLIT STEMS SHOWING (LEFT) DEATH AND SHRINKAGE OF PITH ; (RIGHT) DARK STREAK ON THE MARGIN OF THE PITH

B. THE TWO DARK STREAKS ARE MADE BY BACTERIA WHICH WILL INFECT THE SEED

C. EXTERNAL INFECTION OF THE FRUIT. THE WHITE HALOS AROUND THE SPOTS ARE DIAGNOSTIC

D. WHIPTAIL OF CAULIFLOWER

THIS DISORDER IS ASSOCIATED WITH A DEFICIENCY IN THE SOIL OF EITHER LIME OR MOLYBDENUM

NOTES ON THE COMPOSITION OF SOME OF THE COMMON POULTRY FEEDING STUFFS (COMPILED FROM VARIOUS SOURCES)—*contd.*

	Dry Matter	Digestible Percentage			Fibre	Ash	Nutritive Ratio
		Protein	Carbo-Hydrates	Fats			
Meat Meal . . .	89·2	55·7	—	12·5	—	3·8	—
Meat and Bone Meal .	90·8	39·0	—	9·4	—	23·1	—
Oats and Sussex Ground Oats . . .	86·7	8·0	44·8	4·0	10·3	2·8	7·0
Palm Kernel Meal .	90·0	16·0	47·0	1·75	16·0	4·0	3·2
Peas . . .	86·0	17·0	53·0	1·0	6·0	1·5	3·25
Potatoes . . .	25·0	0·1	19·0	0·1	1·0	0·75	192·0
Rice Meal . . .	91·0	7·0	42·0	11·0	7·0	8·0	9·6
Soya Bean Meal (extracted) .	88·7	40·3	24·7	1·4	5·1	5·5	0·7
Wheat. . . .	87·0	9·0	65·0	1·25	2·0	2·0	7·5
Wheat Middlings . .	86·5	13·8	45·5	4·3	5·3	6·1	4·0
Wheat Bran . .	86·4	10·6	38·0	2·8	10·6	5·8	4·0
Whey	7·0	0·8	5·0	0·25	—	0·75	7·0
Yeast (dried) . .	95·7	41·6	29·2	0·2	0·5	10·7	0·7

The function of the gizzard of a hen, being to reduce the food to such a state that the digestive juices can act upon it, the feeding of grit is a great aid to the grinding efficiency of this organ. Grit should be supplied to all birds where, on range, a plentiful supply is not found, or where they are kept under intensive conditions. Palatability is most important and should not be overlooked in feeding. Hens have their likes and dislikes. Musty or stale food may cause trouble and should be avoided. Whilst sudden changes must not be made in the rations, hens like variety, and the best rations are those made up of several kinds of feeding stuffs.

STARCH EQUIVALENT.

Many of the published tables which give the composition of feeding stuffs include a column headed "starch equivalent." This shows the starch value of the digestible food stuffs in each 100 lb. of feeding stuff, and is useful for comparing one food with another. The starch value can be found by multiplying the digestible fats by the factor 2¼, the digestible protein by 0·94, and adding the result to the digestible carbohydrates.

Bran = 2·8 – 2·25 plus 10·6 × 0·94 plus 38·0 = 54·3 = Starch equivalent.

FOOD UNITS.

An idea of the money value of one food stuff as compared with another is useful in making up a ration. This can be found by taking the percentage of proteins, fats and carbohydrates and turning them into terms of food units. Both the protein and fats are multiplied by 2¼ and then added to the carbohydrates to give the number of food units. This number divided into the price, will give the cost per food unit.

Example:

	Barley.		Maize.	
Protein	6·5×2·25—	14·625	7·0×2·25—	15·75
Fats	1·2×2·25—	2·70	4·5×2·25—	10·12
Carbohydrates	62·2×1·0—	62·20	68·0×1·0—	68·00
		79·25		93·87
Price per ton	£20		£20	
cost per unit	5/-		4/3	

This shows that maize at £20 per ton is a

cheaper food than barley at the same price, if used in a properly balanced ration.

NOTES ON VARIOUS FEEDING STUFFS.

ALFALFA MEAL is dried Lucerne and is a useful feed for laying stock. Yolks are improved in colour by its use. Its fibre content is high and this prevents its liberal use.

BARLEY is not extensively used in poultry rations. Where fed indiscriminately trouble has been caused, but experimental work has shewn that it may very well be used in a properly balanced ration. Barley meal is often used with success in fattening rations.

BEANS, which are fed as meal, are rich in proteins but deficient in fats.

BREWERS' GRAINS are rich in protein, highly digestible, and a useful food for laying stock. Probably owing to their bulkiness and cost of transport, they are not so much used as they might be.

FISH MEAL is rich in protein and can be fed to all kinds of stock. If not fed in excess of 10 per cent, there is no fear of the eggs, or flesh of fowls being tainted.

MAIZE is extensively used in poultry feeding, both in its kibbled state and as meal. Essentially a carbohydrate food it contains very little fibre. Yellow maize is used in nearly all cases. With layers, it has a definite influence on the colour of the yolk. White maize meal is used a great deal in fattening mashes, because the yellow variety has a tendency to increase the yellow colour in the fat of the bird.

MAIZE GLUTEN is a by product from the making of glucose and starch. It is rich in protein. MAIZE GERM MEAL (a by-product in making corn flour) is rich in oil, and care must be exercised in its use, as, in excess, it is bad for the birds.

MILK is extensively used in feeding young chicks and in fattening birds for the table. It is also employed in rations for growing and laying stock, when it can be purchased at a reasonable figure. Milk is used either in its liquid form or dry and is either skimmed or separated. WHEY resulting from cheese making, does not possess the high protein content of other milk products, being chiefly a carbohydrate food, but is valued for its mineral and vitamin content.

MEAT MEAL AND MEAT AND BONE MEAL are rich in protein. They can be used in place of fish meal.

OATS and SUSSEX GROUND OATS. Oats are a useful food, though not used now to the extent they were some years ago. Valuable for its mineral and oil properties, its high fibre content makes it less acceptable than wheat. SUSSEX GROUND OATS have always been a stand-by in the fattening yard, and they are also used extensively in chick mashes. The whole oat, including the husk, is ground to meal in making SUSSEX OATS. This is very different from crushed oats. When grinding, a little barley is often included with the oats.

PALM KERNEL MEAL can be given in a mash to replace some other cereal by-products, but it should be used with caution owing to its unpalatibility if fed in large quantities.

PEAS, like beans, are fed as meal. They are rich in protein, but deficient in fat.

POTATOES are a carbohydrate food. Chat potatoes have always been used in mashes for poultry, but it is only recently that experiments have shown that they can be used to a much greater extent in a mash. As a war-time measure steamed potatoes were used in a layer's ration with success up to the extent of 70 per cent, the rest of the mash being made up of middlings and fish meal. In rearing chicks from day old also, steamed peeled potatoes have constituted 70 per cent of the mash with good results in growth.

RICE is a carbohydrate food and is low in protein. Some years ago rice was used in chick feeds a good deal. It is highly digestible and probably the cost is the reason for its limited use now. Care should be taken in purchasing RICE MEAL. It consists of the bran and polish removed when the seed is being prepared for human consumption, and owing to the oil it contains readily goes rancid on storage.

SOYA BEAN MEAL (extracted) in its protein content is somewhat similar to milk. With it minerals are usually fed.

WHEAT (including the by-products BRAN and MIDDLINGS). One of the most used grains in poultry feeding. It can be employed for all classes of stock. BRAN is the outer covering of the wheat, and is generally used to add bulkiness to the ration. It is useful, both as a source of protein and of Vitamin B, but has a high fibre content. Owing to its bulkiness it is not used in large amount in chick mashes. MIDDLINGS (sometimes known as SECONDS or THIRDS in different parts of the country), is the residue in the milling of wheat flour, and is extensively used in poultry mashes for all stock. Samples vary a good deal, there being sometimes very little difference between fine bran and middlings.

DRIED YEAST is fed to young chicks, growing, breeding, and laying stock, for its high protein and vitamin content.

Feeding.

FEEDING METHODS. Feeding time is the best opportunity the poultry farmer gets to have a good look over the birds and see if anything is wrong, so time spent on feeding is never wasted. Where dry-mash feeding alone is practised it will not be so easy, for the birds will be at the hoppers in twos and threes all day. With wet-mash feeding or when corn is given, one can get practically all the birds close at hand.

There are several systems of feeding, the old way with wet-mash, and the more modern practice of mash fed dry, and grain feeding. It

is possible to feed dry-mash successfully, without giving any grain whatever. Grain alone can also be fed. This is still the practice where birds are a sideline on the general farm, and have the run of the farmyard. To feed grain alone would not be economically sound on a poultry holding, nor would it, except in the spring flush, make for the maximum egg-production. On most farms it will be found that dry- or wet-mash is fed in conjunction with a grain feed.

Wet-Mash.

To prepare a wet-mash does not mean taking a dry-mash mixture and adding water to it. It is not so simple as that, if it is done properly, although it is a method often practised. Such ingredients in the ration as maize meal, Sussex Ground Oats, wheat meal, and fish- or meat-meal, should be steeped in hot water and left for a time. When thoroughly soaked the mixture can be dried off by the middlings and bran in the mash. Bran should not be soaked. Care must be taken not to use too much water, but only sufficient to be thoroughly absorbed by the different ingredients. Wet-mash feeding is a great advantage where only a few birds are kept, or where a large institute or school is running a poultry department, for kitchen waste and surplus garden produce may with advantage be incorporated in a wet-mash. When ready for use the mash should be in a crumbly state, not in a sloppy condition. It should always be fed in troughs. Never scatter it on the ground where it can go mouldy, and become a menace to the birds. One drawback to wet-mash feeding is the labour it entails on a large holding. The preparation, mixing, and carting round the food every day does take up an amount of time which some might think could be more profitably employed in other directions. At the same time there is probably not so much wastage from spilt food or possibly from vermin, when wet-mash feeding is practised.

Dry Mash Feeding.

Dry Mash Feeding is practised extensively. It has many advantages. The food can be mixed in bulk once or twice a week, and carted round to the different houses. The saving of time and labour is obvious. Dry-mash is fed in hoppers, which in the case of the larger houses, are fitted inside the house, at such a height from the ground as to make it readily accessible to the birds. Since in most cases the hoppers are open all day or most of the day, there is not that scramble which occurs amongst the birds in wet-mash feeding, and all of them have ample time for satisfying their appetites. Dry-mash feeding can be very wasteful if a proper kind of hopper is not used.

The custom in some quarters of leaving the hoppers open all night is not to be recommended, as it attracts vermin, and rats can make a big inroad into the mash if given the opportunity. For the same reason, galvanized hoppers are better than wooden ones. It has been said that dry-mash feeding is not so satisfactory, and does not give such good results as wet-mash. Experimental work does not bear out this contention, except in case where the mash, when fed dry, proves unpalatable. In such cases, wetting the mash may result in an improvement. Equally good results have been obtained on both systems, and the one to use is merely a matter for the poultry farmer to decide for himself. The personal element in feeding counts for a good deal, and however excellent the food, good results will not be achieved unless the birds are properly fed. It is to be deprecated that more care is not taken with the feeding now-a-days. To throw the grain down all in a heap is not a good practice. A certain amount of grain feeding is advantageous, for not only does it provide variety in the diet, but it is easy to feed, and keeps the gizzard properly employed. If not given until just before it gets dark, then it is better to feed it in troughs. If fed in the morning, it should be scattered in the litter especially in the large intensive or semi-intensive houses. This will get the birds scratching and actively employed. For the same reason, it can be broadcast on range after the birds are let out, if the weather be suitable.

Grain.

Where mash and grain feeding are practised, it is usual to feed two ounces of grain per bird per day, on the assumption that an adult bird will consume approximately four ounces of food per day, and it is desired to give two ounces of mash and two ounces of grain. A hard and fast rule should not be made in this direction for it is a good thing to let the birds have all they will eat of a well balanced ration. However, let half of it be grain. Wet-mash may be given in the morning and grain at night or the order may be reversed. It used to be contended that grain remained in the crop longer than the mash, and that was the reason for the custom of feeding the grain later in the afternoon. Experiment has proved the contention to be incorrect. When feeding corn in conjunction with dry-mash, it is a good thing to give say half an ounce of grain in the litter in the morning per bird. The dry-mash hoppers should be left open all day, giving the balance of one and a half ounces of grain as the last feed, in the trough for preference. Some feeders in addition to giving dry mash and grain, will feed a small quantity of wet-mash at mid-day, especially during the winter months.

There is no one correct system to follow. The keen poultryman will adopt a certain way of feeding, and watch results. If he feels that he can do better by changing his methods he will be wise to make the alteration.

PELLET FEEDING (that is dry-mash made up in

the form of pellets), is being followed by some poultry keepers who use the battery system. An advantage in using pellets is that there is little waste in feeding.

RATIONS FOR CHICKS BEING REARED OUT OF DOORS
(All parts by weight.)

	Wet or Dry Mash (1 to 8 weeks)	*Dry Mash (1 to 8 weeks)*
Bran	20 parts	3 parts
Middlings	35 ,,	6 ,,
Sussex Ground Oats	20 ,,	4 ,,
Maize Meal	15 ,,	4 ,,
Dry Skim Milk	10 ,,	—
Meat Meal	— ,,	5 ,,
Bone Meal	—	1 ,,
	100 ,,	23 ,,

Add:
Cod Liver Oil—2 parts
Minerals— 2 ,,

Grain
Cracked Wheat—1 part
Cracked Maize —1 ,,

Mineral Mixture composed of:

Steamed Bone Flour	1 part
Chalk	1 ,,
Salt	½ ,,

GROWING CHICKS ON RANGE.

	Wet or Dry Mash	*Dry Mash*
Bran	20 parts	20 parts
Middlings	35 ,,	35 ,,
Sussex Ground Oats	25 ,,	20 ,,
Maize Meal	15 ,,	15 ,,
Fish or Meat Meal	5 ,,	—
Meat and Bone Meal	—	10 ,,
	100 ,,	100 ,,

Grain
Wheat 1 part
Cracked Maize 1 ,,

Grain
Wheat 1 part
Cracked Maize 1 ,,

FATTENING RATIONS (TABLE CHICKENS).

(1) Sussex Ground Oats — 13 parts
Dried Skim Milk (the Sussex Ground Oats and milk to be mixed with water to a consistency of thick cream) — 1 ,,
One part of mutton fat added to above for fattening.

(2) Maize Meal (White) — 6½ parts
Sussex Ground Oats — 6½ ,,
Dried Skim Milk — 1 ,,

(3) Barley Meal — 6½ parts
Sussex Ground Oats — 6½ ,,
Dried Skim milk — 1 ,,

(4) *For fattening birds in their rearing quarters.*
Sussex Ground Oats — 2 parts
Barley Meal — 2 ,,
Steamed Potatoes — 1 ,,

LAYING BIRDS ON RANGE.

	Wet or Dry Mash	*Wet Mash*	*Dry Mash*
Bran	20 parts	14 parts	25 parts
Middlings	40 ,,	35 ,,	35 ,,
Sussex Ground Oats	20 ,,	35 ,,	10 ,,
Maize Meal	10 ,,	—	20 ,,
Fish Meal	10 ,,	10 ,,	10 ,,
Alfalfa Meal	—	6 ,,	—
	100 ,,	100 ,,	100 ,,

GRAIN FEED (FOR THE ABOVE LAYING MASHES).

Wheat	1 part
Cracked Maize	1 ,,

RATIONS SUITABLE FOR BATTERY AND OTHER METHODS OF REARING (ALL PARTS BY WEIGHT).

Dry Mash for Chickens (from day old to 14 weeks)

Bran	20 parts
Sussex Ground Oats	15 ,,
Maize Meal	25 ,,
Alfalfa Meal	5 ,,
Middlings	15 ,,
Dry Skim Milk	5 ,,
Fish or Meat Meal	7½ ,,
Linseed Meal	2 ,,
Dried Yeast	2½ ,,
Cod Liver Oil	1 ,,
Minerals	2 ,,
(Give 2 parts C.L.O. in winter)	
	100 ,,

Mineral mixture for above:

Steamed Bone Flour	2 parts
Chalk	2 ,,
Salt	1 ,,
	5 ,,

Grain feed at night:
Cut wheat to 6 weeks
Whole wheat 6 to 14 weeks
Fine Flint Grit ad lib.

Growers Mash (Dry):

Bran	20 parts
Midlands	35 ,,
Maize Meal	25 ,,
Sussex Ground Oats	13 ,,
Fish or Meat Meal	5 parts
Minerals	2 ,,
	100 ,,

Minerals as for chicks.
Grain whole wheat.
Flint Grit ad lib.

Mash calculated to keep chickens growing and developing a good-sized frame, and producing big framed store chickens. (Especially suitable for chickens that are going to be fattened.) (1).

Bran	20 parts
Middlings	25 ,,
Sussex Ground Oats	20 ,,
Maize Meal	21 ,,
Fish Meal	5 ,,
Linseed Meal	2 ,,
Dried Yeast	3 ,,
Minerals (*See* following table)	4 ,,
	100 ,,

Mineral Mixture for (1).

Chalk	2 parts
Steamed Bone Flour	2 ,,
Charcoal	2 ,,
Salt	1 ,,
	7 ,,

An All Mash Ration (*No grain*) *for chicks reared intensively.* (2)

	Up to 8 weeks	*After 8 weeks*
Bran	25 parts	20 parts
Sussex Ground Oats	10 ,,	10 ,,
Maize Meal (Yellow)	19 ,,	32½ ,,
Alfalfa Meal	5 ,,	—
Middlings (straight run)	24 ,,	18 ,,
Dry Skim Milk	10 ,,	6 ,,
Fish Meal (60% albs.)	—	7½ ,,
Dried Yeast	3 ,,	2½ ,,
Cod Liver Oil	1½ ,,	1½ ,,
Minerals (*See* following table)	2½ ,,	2 ,,
	100 ,,	100 ,,

Mineral Mixture for (2).	*To 8 weeks*	*After 8 weeks*
Charcoal	¾ part	2 parts
Steamed Bone Flour	—	2 ,,
Chalk	1½ ,,	2 ,,
Salt	¼ ,,	1 ,,
	2½ ,,	7 ,,

Breeders Rations

Wet Mash

Middlings	4 parts
Maize Meal	2 ,,
Sussex Ground Oats	1 ,,
Fish or Meat Meal	2 ,,

Grain.

Wheat	1 part
Cracked maize	1 ,,

Dry Mash (*Summer*)

Bran	15 parts
Middlings	45 ,,
Sussex Ground Oats	13 ,,
Maize Meal (Yellow)	17 ,,
Meat and Bone Meal	10 ,,
	100 ,,

Dry Mash (*Winter*)

Bran	15 parts
Sussex Ground Oats	12 ,,
Maize Meal (Yellow)	21 ,,
Middlings	40 ,,
Dried Skim Milk	5 ,,
Dried Yeast	3 ,,
Fish Meal	3 ,,
Cod Liver Oil	1 ,,
	100 ,,

Grain Feed
(for both of the above)

Wheat	1 part
Cracked Maize	1 ,,

Rations for Turkeys

First Week. Give Biscuit Meal rubbed off with Middlings or Sussex Ground Oats, using skimmed milk if available.

Two to Eight Weeks.		*Eight weeks to Fattening.*
Middlings	4 parts	3 parts
Sussex Ground Oats	2 ,,	1 ,,
Maize Meal	2 ,,	2 ,,
Bran	2 ,,	2 ,,
Meat or Fish Meal	1 ,,	1 ,,
Alfalfa Meal	1 ,,	
Dried Skim Milk	1 ,,	
Cod Liver Oil	1 pint	

(per 100 lb. mash).

Fattening. Equal parts of Middlings, Barley Meal, Maize Meal, and Dried Skim Milk, mixed to a crumbly mash, or Sussex Ground Oats and Skimmed Milk as for Table Chickens. Soaked grain can be given if desired.

Rations for Ducks

First Week. As for Turkeys.

Two to Fifteen Weeks		*Laying Ducks*	*Fattening*
Bran	2 parts	2 parts	1 part
Sussex Ground Oats	2 ,,	2 ,,	2 ,,
Middlings	4 ,,	6 ,,	2 ,,
Maize Meal	1 ,,	2 ,,	—
Meat or Fish Meal	1 ,,	1 ,,	
Barley Meal			2 ,,
Skimmed Milk			1 ,,

Soaked Grain may be given as a second feed if desired with the above mashes. Feed mashes in a crumbly state.

Rations for Geese

Feed the same as for ducks up to 7 or 8 weeks. When they go on to grass give two feeds of soaked grain per day. Fatten the same as for ducks, but give steamed potatoes in the mash if available.

Guinea Fowls should be reared in the same way as advised for chickens.

Note.—No War-Time rations are given here, it being considered that the food stuffs used in normal times of peace mashes, will again be available in the near future.

DISEASES

The necessity for cleanliness. Treating ordinary ailments. Steps taken to prevent disease. Identifying various symptoms. Short description of some of the common poultry diseases.

Knowledge of the Diseases.

IT is of vital importance that the poultryman should have some knowledge of the diseases that he may possibly run up against in the course of his work. He should also know what initial steps to take to counter any outbreak (especially in infectious cases), pending the arrival of professional help. Whilst he should not deal with a serious outbreak, or with something he does not understand, without expert assistance, there are ailments, the cure of which he can very well undertake. Above all, he should be thoroughly conversant with all the preventive measures necessary to keep certain diseases at bay. It may be the means of saving him a good deal of money and worry in the long run, and it is a duty he owes to his fellow poultrymen. Perhaps one of the penalties of keeping birds in large numbers is that they are really not seen so thoroughly or so frequently as used to be the case. As a rule, there is so much to do and so little time in which to do it. At the same time every endeavour should be made to look over the stock when possible. When wet-mash feeding was the rule, opportunity was always had to run an eye over the birds. The same applied when corn feed was given. Now, with dry-mash feeding, the generally accepted practice—and in some cases with no additional corn feed—the every-day inspection has fallen into abeyance. There is always a danger when no inspection is regularly undertaken, that a common cold will be overlooked, sometimes with serious consequences. In particular where large houses are used, it is a good practice to visit them after nightfall, so that in the quiet of the night a bird suffering from the beginning of a cold can be readily detected, removed, and promptly treated. Cleanliness in the houses, and with feeding and watering utensils, is essential. As we have said. most poultry houses are fitted with dropping boards under the perches. These should be cleaned as a matter of routine at least twice a week, every other day would be better. All water vessels should be kept clean, and the vessels scrubbed out with hot water at least once a week. Perches and other fittings should be movable, A thorough cleansing of house and fittings is most usefully done when the house is empty, and before the pullets are brought in for laying. Litter should be renewed as often as required, generally about twice a year, and the whole removed and burned when the annual cleaning takes place. The ground immediately outside the house should also have attention. Whether the extensive or the semi-intensive system is used, unless the house can be moved occasionally, it will be found advisable to clean up thoroughly the ground immediately surrounding the house, and cart the droppings away. Even if the runs are of grass, the ground will be found to get bare in front of the outlets in a very short time. All houses should be so placed that they get the maximum amount of sunlight playing on them, and the ventilation should be such that a good supply of fresh air (not a draught) is available. When a bird has been removed and isolated owing to suspected trouble, unless it is soon well again, it is questionable whether, on an ordinary commercial holding, it is advisable to keep it. It is understandable that the farmer or pedigree breeder will want to keep a valuable bird, but the ordinary layer, even if cured, will not eventually be put into the breeding pen. It is doubtful whether she will come into lay again or prove a profitable bird. Such being the case she is probably better killed so that she ceases to be a menace to the rest of the birds.

New Stock.

New stock should never be put in with one's own hens at once, but kept isolated for a few days; especially is this necessary when the birds have come a long distance. Though not apparent at the time, they may develop a cold and it can be dealt with effectively if they are by themselves. Examine the birds on arrival for physical defects. Examine the mouths; here any white or yellow patches may denote roup and will call for prompt action. Body lice should be looked for. Naturally, purchased birds, which arrive suffering from any ailment, or showing signs of illness, should be returned to the vendor. It should always be one of the conditions of sale that such birds are returnable. All dead birds should be burned if possible. If they are not, they should be buried in lime in a deep pit.

How should one know when a bird is unwell? Disinclination to take food is a sign, so is a discoloured comb or a half alive looking appearance.

Diseases to which poultry are susceptible may be grouped roughly—with examples—for the poultry farmer as:—

Ailments due to management or feeding: bumble food, visceral gout, crop binding, sour crop, cannibalism, feather pecking, egg eating.

Caused by parasites:
External—lice, fleas, and mites.
Internal—parasitic worms, coccidiosis.

Caused by fungi or moulds: aspergillosis and favus.

Non-infectious diseases: rickets, peritonitis.

Caused by virus: fowl paralysis, fowl pox, contagious catarrh.

Caused by germs: bacillary white diarrhoea (B.W.D.).

Affections of the ovary and oviduct are of fairly

frequent occurrence in these days of high producing hens. *Prolapsus* or *protrusion of the oviduct* can readily be seen, and is caused through straining to pass an egg, part of the oviduct protruding through the vent. To treat this trouble, wash the part protruding in warm water, and after applying vaseline, gently return the organ with the finger. The bird should be better after a few days on a light diet of soft food.

A hen may become *egg bound* (unable to pass the egg), possibly through its being unusually large. In this condition it will be noticed that the hen will keep visiting the nest without result, and will show signs of distress. She can often be relieved by holding her with the vent close over a jug of boiling water, when the egg can be got away. One must be very careful in handling a bird suffering in this way for if the egg be broken, it will probably be impossible to save her, and she should be killed. When the egg is removed, the hen should be put on a light diet for a few days.

Legs and Feet.

Affections of the legs and feet include leg weakness, and bumble foot. *Scaly leg* is very unsightly and is caused by a mite which burrows underneath the scales of the leg. In bad cases the scales seem to swell out into large lumps and then crack, causing bleeding. The shanks should be dipped into paraffin, or better still the paraffin should be applied and well brushed in with an old brush. *Leg weakness* may occur both in young chicks and in adult stock. With the young stock it may be due to lack of Vitamin D, caused by a want of sunlight, or the absence of cod liver oil from the mash. On the other hand it may be caused by overheating in the brooders. In older birds, leg weakness may be caused by rheumatism, and the legs should be treated by bathing them in warm water, and after drying them rubbing in embrocation or turpentine. Leg weakness in adult birds should not be confused with fowl paralysis (neuro-lymphomatosis), a disease which has been very prevalent in the poultry industry in recent years.

A growth, usually an abscess, on the bottom of the foot, which will sometimes be found in adult stock, is known as *Bumble foot*, and is usually caused through the hen flying down from a high perch on to a hard floor, or to ranging on very hard and stony ground. Bumble foot is very painful for the bird, which will soon become lame. The abscess should be pierced with a sharp clean knife, and the pus squeezed out; the wound should then be thoroughly cleaned with a weak solution of carbolic solution. The foot should be kept bandaged for a few days, or the bird kept isolated on clean straw for the same period. A fibrous-tissue pad sometimes develops as a result of repeated concussion in cases where there has been no penetration of infection through a wound. The pad acts as a cushion and is permanent. No attempt should be made to lance it. Evidence of pain or marked lameness is not a feature of this condition.

External Parasites: Lice, Fleas and Mites. Constant watch should be kept for vermin of the insect and allied classes. One does not see the dust-bath so customarily established on poultry farms to-day as it was some years ago. It is very useful and the hens can be relied upon to make good use of it if it is kept in order and properly attended to, being cleaned out when necessary, and renewed with fresh earth, or better still, with finely sifted ashes. The straw or hay in the nests should be renewed as occasion demands, and the nest boxes ought to be kept clean. The birds should also be watched, and if lice are suspected, they should be treated with sodium fluoride, a pinch being put among the feathers in various parts of the body, particular attention being paid to the fluff under the wings, and to the area round the vent. The sodium fluoride should be kept away from the eyes of the bird, and not allowed to get into the vent. Mites can be a great nuisance, and watch must be kept for them as they are most active at night time. Their hiding places are cracks in the walls of the house, and they are particularly partial to the sockets in which the perches rest. Here will be found the Red Mite, so called from the red colour it exhibits when it has been attacking and drawing blood from the hens during the night. Every attempt must be made to keep this pest under control. Houses should be thoroughly creosoted and lime-washed if necessary, when empty. During the year, perch sockets should be treated occasionally with a dab of paraffin, or with creosote, and the perches themselves should be painted with nicotine sulphate, which is a particularly effective treatment for lice. *Depluming Mites* are parasites which attack the bases of the feathers, causing them to fall out. Sulphur ointment should be thoroughly rubbed into the affected parts. *Internal Parasites: Gapes* in chickens is caused by small worms which multiply in the windpipe. The trouble can be recognized by the chick wheezing a lot and running about in a distressed condition with beak open. The chick should be caught up at once, and a feather that has been dipped in turpentine worked up and down the windpipe. This will probably dislodge the worm, or worms, which are then coughed up. The chicks should be removed to a fresh piece of ground to avoid further infection. *Flat and Round Worms.* Where poultry are affected by parasitic worms, the vitality of the stock may be quickly and seriously lowered. Flat worms which can hardly be seen by the naked eye are found adhering to the lining of the small intestine. These are only found in adult fowls.

The small round worms are found in the cæcal tube or blind gut, and are about a quarter to half an inch in length. Large round worms confine themselves to the small intestines, and look like

long pieces of string where several are entwined together.

Treatment is difficult, for where the round worm is simply expelled from the bird and not killed, reinfestation can take place.

Proper advice should be sought where worm infestation is suspected, for, if a proper job is to be made of cleaning up the trouble, not only must the birds be treated, but the land also on which they have been running. *Tapeworms*, which are relatively common fowl parasites, can be detected by the appearance of the whole or part of the worm in the droppings. They are flat and like ribbons, and affect the domestic hen, adhering to the wall of the intestine. A few worms may not affect the health of the bird, but the fowl will soon go out of condition if the worms are numerous. Turkeys and geese are very susceptible to tapeworm infestation, but ducks, though they harbour the worms, are rarely affected. Birds affected will often suffer from diarrhoea, after a time they become thin, and very weak and death may supervene. Tapeworm eggs are expelled by the hen with the droppings. These eggs do not infect a fowl until an intermediate stage has been passed in the body of some small form of animal life, such as a snail or a slug. Poultry will become infected by eating these snails or slugs which are known as, intermediate hosts. The Ministry of Agriculture advises in an outbreak of this kind, to treat the land over which the birds have been running with a mixture of two parts copper sulphate to eight parts of fine sand broadcast at the rate of 3 cwt. to the acre, or 1 lb. to every 15 square yards: this is in order to destroy slugs and snails which may be spreading the trouble.

Sometimes birds will be found to be in what is known as a *Crop-bound condition*. This is due to an obstruction in the passage leading from the crop to the stomach. It is usually recognizable by the distension of the crop to a marked degree. It will often be caused by birds eating old tough grass which becomes bound like a soft ball in the crop. Sometimes massaging or kneading the crop with the fingers and giving a dose of oil—repeating the process every two hours—will give the necessary relief. Failing this the crop must be opened with a sharp knife by making a perpendicular cut a little more than an inch long in the upper part of the crop. Then all the contents should be removed, and the crop washed out throughly with warm water. Finally each skin should have a few stitches put into it to close it up. For a few days it is well to keep the bird isolated, giving it a soft mash feed for a few days, and skimmed milk if available.

Soft Crop must not be confused with crop binding. The crop is distended in the same way, but is filled with a watery fluid. This can be got rid of by holding the head of the bird downwards and gently massaging the crop, the operation to be repeated until all the fluid is evacuated. The bird should be well after a day or two, on a light warm mash diet.

Of all the diseases that young chicks are liable to, Baccillary white diarrhoea and coccidiosis are responsible for an enormous number of casualties yearly, and yet if effective precautions be taken, these diseases cease to be a menace.

Bacillary White Diarrhoea or Pullorum disease usually attacks chickens during the first week after hatching: it is then that most of the casualties will occur, although losses may still follow for a week or two later. Chickens affected with this disease appear listless, with dropped wings and the feathers around the vent become pasted up with a whitish matter. Mortality may be very high in a short time, and it will be possible to pick out dead chickens two and three together at all hours. The disease is caused by an organism called *Salmonella pullorum*. This infects the ovary of the hen. Chicks hatched from eggs from an infected hen, may affect healthy chicks from other eggs being incubated at the same time and the disease will make its appearance soon after hatching. Chicks which recover from Bacillary White Diarrhoea are a potential danger, for they may retain the causative organism in their bodies, and this may later make its way into the ovary. Chicks can contract the disease from the droppings of infected chicks. The sure and proved way of preventing it, is to use only eggs from stock that is not affected. Hens are tested for the presence of Bacillary White Diarrhoea by what is known as the Agglutination test, a blood test which will be done for poultry farmers by a Veterinary Laboratory at a small charge. So reliable has this test proved that it has now become the custom for purchasers buying new stock to insist on a guarantee that the stock from which hatching eggs, day-old chicks, or growing stock has come, has been subject to the Agglutination test and has been found free. Laboratories that undertake the Agglutination test for poultry farmers send out explanatory leaflets on how to collect blood samples. A quicker test undertaken on the spot, but not considered so reliable in some quarters as the tube Agglutination test, is known as the *rapid test*.

Where a poultry farmer has been unfortunate enough to have an outbreak of this disease, he must take drastic steps in cleansing and disinfecting his incubators and brooders in a thorough manner.

Coccidiosis is a common disease caused by a parasitic organism which works into the intestines and multiplies very rapidly. Unlike bacillary white diarrhoea it does not attack the chickens until they are over three or four weeks old. Many species of animals and birds are subject to *coccidiosis*, but evidence seems to show that the parasite (*Coccidium*) of one species does not cause the disease in any other. The *Coccidium* found in the sparrow or rabbit is not transmissible to the domestic fowl. Large numbers of the

organisms are evacuated with the droppings and healthy chicks are infected by coming into contact with food, water, or soil contaminated with these organisms. Chickens affected will appear listless, their feathers ruffled, and their droppings may be stained with blood. If one of these chickens is killed and opened up it will be found that the cæca (the blind ends of the intestines) are enlarged, the contents looking like a cheesy mass and frequently streaked with blood. Normally the cæca are greyish and not so large. Various remedies for the disease have been advocated from time to time, such as a liberal supply of milk, or catechu powder, but it is only recently that effective control of *caecal coccidiosis* has been achieved by the use of a drug called *sulphamezathine*. In any case preventive measures should be adopted in all outbreaks of *coccidiosis*. If at all possible, fresh rearing ground should be used each season, and droppings should be carefully cleared up and removed. Where intensive rearing is done on wire floors, trouble from this course does not often occur and if it does, can soon be checked. When *coccidiosis* is found infecting adult stock it is better to kill and burn the birds. If they recover they will never be a paying proposition.

Rickets occurs in chicks and growing stock, and can be recognized by a general weakness, a thickening of the joints, and anæmic appearance. It appears mainly in young stock that has been reared intensively. To avoid rickets, chicks should have good quality Cod Liver Oil in the mash, and two per cent of a good mineral mixture. All the sunlight possible should be available, and to this end, intensively reared chicks are often given access to a sun balcony.

Colds are common to all classes of stock, and are often due to faulty ventilation, overcrowding, or ranging through long wet grass. The trouble is recognizable by a discharge from the nostrils, and sneezing. This is not fowl pox, another trouble which is accompanied by an offensive odour. Birds suffering from a cold should be segregated at once and if dry-mash is used, it should be discontinued and replaced by a wet-mash. The drinking water should be "pinked" with a solution of permanganate of potash. Another remedy is 3 ounces of sulphate of copper, 1 ounce of sulphate of iron, and 1 quart of vinegar. The whole should be mixed together and 1 ounce of the mixture given in 1 gallon of drinking water. The medicine should not be put into metal vessels.

Contagious Catarrh is often thought to be just an ordinary cold, but in two or three days the discharge from the nostrils becomes thick, causing the bird to breathe heavily. The spaces below the eyes become swollen and the eyelids may become glued together. Infected birds should be isolated at once, the eyelids being cleaned with cotton wool and the nostrils treated with vaseline.

The ventilation of the house should be looked to. Douglas mixture can be given in the drinking water and Cod Liver Oil from one to two per cent added to the mash.

Bronchitis following a cold, and often followed by pneumonia, should be dealt with by killing off the affected bird, unless it is a very valuable one.

Tuberculosis, or "going light" as it is commonly called in poultry circles, is a contagious disease. Found more generally amongst adult birds, it is said to be contracted from food or water contaminated by the droppings of infected birds, which contain the causal agent. Birds suffering from this disease will readily be recognized from their anæmic or unthrifty appearance. It is useless to treat the birds affected: they are better destroyed and burned. Where valuable birds are concerned, a veterinary surgeon should be consulted. If the house where infected birds have been running can be left empty for a month or two after disinfection, it is a good plan. Tuberculosis is encouraged by dirty, damp, and badly ventilated houses. The tuberculin test for identification of birds in the early stages of infection is essential for completely clearing a flock.

Peritonitis. Losses occasionally occur amongst birds in full lay from peritonitis. This is caused by the rupture of a developing yolk or a ruptured oviduct. Sometimes it is occasioned by the gut being perforated by some sharp substance.

Fowl Pox is a very contagious disease which attacks adult poultry stock. Other names for it are chicken pox, diphtheric roup, avian diphtheria and canker. It can be recognized by a discharge from the eyes, cheesy matter in the mouth, and wart-like growths on the comb and wattles. Where there is a bad outbreak of this disease very heavy mortality may occur. It is unwise to try and doctor infected birds, and they should be destroyed. A vaccine for the protection of fowls against fowl pox is now issued by the Ministry of Agriculture. It is claimed that this vaccine will keep the birds free from the disease for at least four months, and that many thousands of birds have been treated with satisfactory results. Birds subject to this treatment are not affected in their egg yield.

Fowl Paralysis (*neuro-lymphomatosis*) is said to have caused a great deal of mortality in the poultry yards in recent years. It is a disease affecting the nervous system, and invasion of almost any tissue by lymphocytes can occur, causing tumours of the ovary, spleen, liver, and other organs. Usually lameness or dropping of the wing is first noticed. This rapidly gets worse and the birds seem to lose the use of their legs. There is no cure for the disease, which can only be diagnosed with absolute certainty after a microscopical examination. Paralytic symptoms similar to those seen in birds suffering from this disease are also found in birds affected with coccidiosis and intestinal worms, and may, in

such case, be incorrectly attributed to fowl paralysis.

Blackhead, the bugbear of turkey breeders, is a contagious disease affecting the liver and intestines, and usually attacking young birds under six months of age. Affected birds appear to be listless and lose their appetite. These symptoms are accompanied by loss of flesh, and yellowish diarrhoea. The comb often becomes dark. The parasite which causes the disease is said to be transmitted by cæcal worms. Post mortem examination shows the liver with depressed areas of a greyish brown colour surrounded by a zone of inflammation.

Treatment is usually of a preventive nature. Immediately the disease is discovered, affected birds should be separated from the rest of the flock, the latter being moved to fresh ground. There are several preparations on the market for counteracting Blackhead. Injection of these preparations will give a bird a protection of short duration, extending not more than ten days. Repeated injections are required at that interval to prolong the effect. Birds which have already contracted the infection will possibly be saved if treated immediately. Turkeys and fowls should not be mixed. Hens or chicks can contaminate the ground.

Aspergillosis is most common in young chicks. When affected they will be found gasping and breathing heavily. Diarrhoea also occurs. There is no known cure for the disease, which is caused by the spores of a fungus found in stale or mouldy food, damp and musty litter. These should be avoided.

White Comb or Favus is due to a fungus, and can be detected when white spots begin to appear on the comb and wattles. These increase and sometimes spread down the neck. Any birds suffering from this disease should be isolated at once and affected parts treated with tincture of iodine. The house where the birds have been should be disinfected, and it is as well to remove and burn litter if it shows any signs of dampness.

Vent Gleet. This evil-smelling disease can be recognized by a sticky whitish discharge which oozes from the vent. This collects on the feathers round the vent which becomes red and inflamed. Affected birds should be separated from the rest of the flock. It is probably wise to kill and burn them, but if treatment is decided on, then the feathers should be cleansed with disinfectant and the vent syringed with a mild antiseptic daily. It is said that the trouble is usually brought on to a plant by a diseased cockerel which infects the hens it has been put with. This is another reason for carefully inspecting all stock purchased.

Though not diseases, the vices of *cannibalism*, *feather pecking* and *egg eating* may very well be discussed here.

Cannibalism can occur with adult stock as well as with young chickens. It is met with more frequently in birds reared intensively, than with those brought along on other systems. Overcrowding, lack of exercise, too much starch or too little protein in the food are contributory causes. Losses may be serious if the trouble is not checked. Cannibalism is not met with where birds are upon free range. When it is noticed that birds begin to look bare in patches, particularly round the tail, then watch must be kept for this trouble, and when found, treatment started at once. The cause, if known, should be remedied. The chickens affected should have the pecked parts treated with Stockholm tar.

Feather pecking is a vice similar to cannibalism and should be treated in the same way. The feather pecking may, however, be due to a feather mite and in that case the bird should be dusted with sodium fluoride round the affected parts.

Egg eating, usually found with birds kept in confinement or small runs, can be a great nuisance if not soon stamped out. The habit may arise from various causes; a lack of calcium in the shape of oyster shell or limestone grit, or thin-shelled eggs breaking in the nest, may start the trouble. Too few nests, or shortage of nesting material may be the cause of broken eggs. Probably the best thing to do when the culprit is caught is to wring its neck and have it for the table. Meanwhile put a few china eggs in the nests and remedy any shortage that may have occurred. Nests should always be in the darkest part of the house and kept well littered.

Many diseases can be controlled by proper attention, and being aware that trouble may arise from new birds or second-hand equipment brought on to the holding. Also that disease can be introduced through the eggs. A thorough inspection of all stock daily will save a deal of trouble. All birds should be regularly blood tested. Proper ventilation will prevent colds, and correct feeding prevent rickets.

SOME REPRESENTATIVE FARMS

A Pedigree Breeder's Farm, an Egg Farm, a Table Poultry Plant, a General Farm and a Small Holding.

Accredited Breeding Farm.

THE day I visited the Accredited Breeding Farm of Mr. R. Johnstone at Woodchurch in Kent happened to be a Saturday. I expected to find him busy, but had forgotten that on that particular day he allowed his men the afternoon off, and did all the work required to be done himself. Anyone who knows a Pedigree Breeding Farm will realize that it was a bad time to arrive, but Mr. Johnstone, with his usual courtesy, put himself at my disposal quite willingly.

Mr. Johnstone has been established at the "Limes Poultry Farm," Woodchurch, for some 23 years. People familiar with the Weald of Kent, and Woodchurch, with its picturesque church and houses surrounding the village green, will also know what a pretty part of the country this is.

The Office Side.

Before walking round the farm, Mr. Johnstone took me into his office. "This is where a good deal of my work has to be done," he said. "I need good men to work for me as I am sometimes tied in here all day. At times as many as 30 letters will arrive by the morning's post, all of which must be answered by myself. It does not mean simply sitting down and writing a reply straight away. Most of the letters will contain orders, or enquiries. Records will have to be looked up, pedigrees looked over, and order books gone through to make sure an order can be filled on a certain date, perhaps some months ahead." It was fairly evident from what I saw that the office side of a pedigree poultry farmer's business was a formidable affair, and called for the expenditure of a lot of time.

Whilst there have been pedigree poultry farmers in the industry for many years, it is only in recent times that we have had Accredited farms. These are, in brief, farms sponsored by the Ministry of Agriculture. After careful inspection the farms receive the official approval of the Ministry, and are registered as holdings where hatching eggs, day old chicks, or growing and adult stock, can be purchased, with the assurance that the best can be obtained there. It will be realized that a farm does not receive accreditation unless the stock is of a high order. Into this class of farm comes the Limes Poultry Farm, which is some 18 acres in extent, and all of it is grass. A fine sward—Mr. Johnstone informed me that he did no mowing at all, as he ran a flock of sheep to keep the grass down for him.

The Breeds.

The breeds of poultry kept are Light Sussex, Rhode Island Reds and Brown Leghorns. Pure-bred stock is got from these breeds, but Brown Leghorn cocks are mated to Light Sussex pullets and Rhode Island Red pullets to produce a cross which Mr. Johnstone says is very popular to-day. In normal times Mr. Johnstone runs 2,000 stock birds, all of which are trap-nested and recorded in their pullet year, as his business demands. The farm carries two Cabinet Incubators of a capacity of 12,000 eggs. Mr. Johnstone has run these for some years, and he is so satisfied with them that nothing would induce him to change to other types. The total brooder capacity is 4,500. The large brooder house was well filled on my visit to the farm, and I was able to see a fine collection of virile youngsters of different ages. The house was divided into sections well boarded up to prevent draughts, and a sun balcony was attached to allow the chicks to get out into the air. Heat was obtained from the pyramid type of oil brooder. Mr. Johnstone informed me that only cross bred chicks were brooded intensively, the pure-bred stock being brooded out of doors in small unit brooders, and foster mothers, about 150 capacity, and from these chicks go out on to the grass when a few days old. After the brooder stage the chicks go out on range into paddocks kept closely grazed by sheep. These paddocks are only used for poultry during the rearing season. Here the birds are accommodated in Sussex night arks and small unit houses. It was interesting to note that there were no wired runs in these paddocks, the chicks being allowed to range at will. Mr. Johnstone told me that he had no trouble whatever from birds crowding at night into a few arks. He thought he avoided this by keeping the birds confined to the arks for the first week, or ten days, and towards the end of that time letting them out in the evening and giving them their last feed just in front of the ark. As might be expected from a farm of this description, one does not see large laying houses scattered round the fields, since the whole business is devoted to the sale of hatching eggs and stock. So the housing is of the small unit breeding pen type, well spaced out, with adequate wire runs attached. Some 30,000 chicks are as a rule hatched out each season.

Competent Staff.

Both the wet- and dry-mash systems of feeding are practised at "The Limes." With all the trapnesting that has to be undertaken on a farm of this description it is not surprising that a fairly large, and certainly a competent staff must be employed. In addition to Mr. Johnstone himself, who is very actively engaged in the work, there is also a foreman, who does the incubation and rearing, a second man who does the trap-nesting and looks after the stock, and a third man who fills in with the routine work as, and when, required.

I notice on the mating list that Mr. Johnstone

has sent out for the present season, that he supplies day-old chicks to order only, that all breeding stock is drastically culled, and only birds of good type, health, and eye colour, are included in the breeding pens, that birds are regularly sent to the Laying Tests, where many honours have been won, and that all stock is regularly blood tested.

To give an illustration of the work entailed on a Pedigree Poultry Farmer's plant I quote further from Mr. Johnstone's mating list. " Special Pen A.1 contains 2-, 3-, 4-year old hens of good size, eye colour and plumage, with the following records:—

Ring Nos.	965	229	971	208	203	266
48 weeks' record	225	230	211	208	208	207
Ring Nos.	406	401	325	415	373	376
40 weeks' record	206	205	204	201	197	194

Mated to a well-marked cockerel, with blood-red eyes, direct from H.D. Barley, from a tested dam, her record—206 specials, 38 first—244 eggs in 44 weeks. Sire's dam record 44 weeks—91 specials, 143 first and second—236 eggs. All eggs from this pen 2¼ ozs. and over and marked with bird's number."

This extract gives some idea of the enormous amount of work entailed, and detail to be undertaken, in order to have available the information a prospective buyer will probably require. To attain proficiency in this branch of the poultry industry requires years of steady building up, and fortunate the poultryman who now has such officially recognized reliable establishments from which to purchase. It is his own fault if he does not take advantage of the opportunity offered to him.

An Egg Farm.

30 Acres.

Sherfield Egg Farm was as near the ideal holding, to my way of thinking, that I have ever come across. I had certainly seen its like on the cover of magazines advocating a " Back to the land " policy, but I had never hoped to run across it in the rough and tumble of every day life. It possessed nearly all the amenities one looked for but seldom found. About 30 acres in extent, the farm was close to a village but not of the village. It was so secluded and shut off that it might have been a hundred miles away from another habitation. A good hard road ran down to it from the local railway station, which was about half-a-mile away. A frequent service of buses to neighbouring towns was close by.

Lay-Out.

When I paid my visit to the farm, the first thing that struck me was its neat lay-out. Sherfield Farm was evidently not meant for a poultry farm in the first instance. Adjacent to the farmhouse were two ranges of buildings substantially built of brick, and in excellent condition. One small building had been converted into an incubator room, and from the hatching records I was shown I should think it was admirable for the purpose to which it had been turned. A cow shed was fitted up with a range of fattening coops, an open cart shed was used to store the poultry manure. There were two good granaries, one over the other, for storing the feeding stuffs. Other buildings served the purpose of egg packing room, oil store, coal store and plucking shed. Mr. Sheaf, the tenant, must have been saved the expenditure of a deal of capital when he found these buildings to hand, and requiring practically no expense on conversion. He informed me that he took the place over after it had been used as a general holding, and that it had never before been run as a poultry farm. The place was well fenced, with one or two pieces of woodland to add to its attraction, and—an undoubted blessing—main water was laid on to the farm and even the fields.

Production of Eggs.

As its name implies, I found that Sherfield Egg Farm was run for the production of eggs for the table. At least that was its main object. True, a few dozen eggs were sold for hatching and some day-old chicks disposed of locally, but no attempt was made to advertise or push this trade. Neither were any ducks, geese or turkeys kept on the farm. The only breed I found was the Light Sussex for the breeding pens, and that these were crossed with Rhode Island Red cockerels to produce a sex-linked pullet for the laying houses. Mr. Sheaf informed me that he had for some years kept pure White Leghorns and White Wyandottes. Whilst he was satisfied with the egg yield from these two breeds, and whilst the Wyandotte cockerels made a good price on the market for table, he did not regret the change. The cross was giving him a good egg supply, and he had no difficulty in getting rid of all the cockerels he did not want, at day old, or eight weeks old in some cases, to a neighbouring Table Poultry Plant. He had found the disposal of the White Leghorn cockerels quite a problem and on some occasions had no option but to kill them off as soon as he could distinguish them from the pullets. Now he kept back just what cockerels he thought he would require, to do a little table work after his incubation was finished, and so provide some birds for his own household, and some for marketing also.

The Houses.

The total head of laying stock was about 1,500. These were housed in semi-intensive houses of good construction, each taking about 250 birds. The houses were well spaced over the grassland and were provided with runs of ample dimensions,

both in front and back. I asked Mr. Sheaf whether he was satisfied with units of 250; that I thought units of 150 were better and probably safer from a health point of view, but he assured me that he had not experienced any trouble in working on a larger unit. The houses were well broken up into sections, and on my visit I found everything scrupulously clean. As large as the runs were, I found them well worn round the outlets from the house. I was told the ground immediately in front of the houses was regularly swept, the droppings being carted away, and that the top spit of earth was removed and replaced by clean earth every year.

Feeding.

Feeding was done on the dry-mash system which the birds had *ad lib.* A corn feed was given at night in troughs, the birds being given as much as they would clear up in half an hour. In addition a light corn feed was given in the litter in the house the first thing in the morning. Mr. Sheaf said he considered this scratch feed first thing started the birds exercising and was very beneficial to them. Each of the houses was fitted with corn and mash bins in an annexe at the end. The bins were large enough to take a week's supply of both corn and mash, so one mixing and one delivery per week was all that was required in the way of feeding. The fact that there was a tap adjacent to each house was a boon, especially in the hot days of summer.

There were about a dozen breeding pens wired with alternate runs, each pen holding 10 hens and one male bird.

The incubator room contained several hot-water and hot-air machines, of a capacity varying from 150 to 360 eggs. Mr. Sheaf told me that whilst he considered he did as well with hot-air as with hot-water machines, he was of the opinion that on an average he got better results from the 150 than the larger size incubators.

Brooder House.

The brooder house was a long, permanent structure divided into sections and heated with hot-water pipes which ran along the whole length of the building. The house seemed well ventilated, and the windows could be removed if necessary. Outlets from each section led in to wired runs, the chicks having access to the ground. Attempts were made to keep these runs grazed down, but they must obviously very soon become the worse for wear. Mr. Sheaf gave one the impression that he would be glad if his rearing results were better than they were, and I suggested that this might be met by fixing up a sun balcony for the chicks with a wire floor, instead of letting them onto the ground. It seemed to me that the latter must become foul despite all the trouble that was taken to cleanse it.

Rearing Ground.

From the brooder house, the chicks, after being cooled off, went straight out to their rearing ground, and were allowed to range. They were accommodated in the ordinary Sussex night arks, and these were so well spaced in three or four acres of meadow, that it was not found necessary to wire the birds in. A temporary wire fence was put round each ark when the birds were first put out, but that was removed after a few days, and Mr. Sheaf told me he had no difficulty with the birds crowding into the wrong arks at night. Dry mash was fed in hoppers attached to each ark, and water was kept close at hand in each case. Being in a hunting county Mr. Sheaf found it wise to close up all his stock at night. The farm had two of these rearing paddocks each used in alternate years. When not in use Mr. Sheaf had no difficulty in letting off the grassland to a neighbouring farmer. The chicks remain on range until the time comes for them to go into their laying quarters.

Paddock.

In a smaller paddock cockerels are run by themselves. These are also housed in arks until the time comes for fattening them. They are then brought in to the fattening cages where they are trough fed on the orthodox mixture of Sussex Ground Oats and skim milk for two or three weeks the time depending on the readiness of the birds to consume their food. Killing and plucking by hand is done on the farm and the birds are sent away by train, about thirty at a time packed in the Sussex Ped, to the wholesale markets in London.

All eggs are marketed through a Packing Station.

I asked Mr. Sheaf whether he had ever co-sidered doing a retail trade in eggs and poultry, but he said he did not think the trouble involved was worth it, and that he much preferred the wholesale markets.

Mr. Sheaf, I gathered, did the whole of the work himself. Certainly he did not employ any outside labour. It did seem to me, however, that members of his household took a lively interest in the poultry, and I formed the impression that he was able to call on help from them when the necessity arose.

Certainly this was a well-run little farm. The fact that it was so well provided with buildings which were included in the rent, helped materially when initial outlay had to be considered. The acreage of the farm was ample and enabled certain areas to be rested when occasion demanded.

A Table Poultry Plant.

Table Plant.

The Table Poultry producing farm of Mr. Smith was a compact little holding with no large fields to tramp over. Nevertheless it was a hive of industry. Somehow this kind of establishment suggests factory lines more than any other sort of poultry holding. It was, however, typical of the

successful Table farm. The first thing that impressed one was the absence of breeding pens and large laying houses. In one fairly large paddock were Sussex night arks, most of them in use for growing chicks; a sun-balcony running the whole length of what was undoubtedly a brooder house was fairly full of birds ranging from one week to six weeks old; a large open shed was full to capacity with crated birds, and in an adjoining building plucking was nearly finished at the end of what had obviously been a very busy morning. Such is a bird's eye view of the present day Table Plant.

Regular Intake.

Though having plenty to do, Mr. Smith courteously gave me of his experience and time to talk about this particular class of work. I was surprised to hear that he was able to get all the day-old chicks he required during the year from Hatcheries and Breeding Establishments. I know of course there would be no difficulty in the Spring months, but he assured me they were forthcoming at other seasons. For the greater part of the year he was able to get cockerel chickens, at other times when, perhaps, incubation had to be done specially for him, he had to take pullet chickens as well. The whole success of the place depended upon a regular intake of day-olds each week and a corresponding output of chickens to market, also each week. This went on for ten months of the year. The remaining two months were devoted to a thorough clean-up of the plant, housing, utensils and appliances, and time for a break for the staff. It will readily be appreciated that being able to purchase reliable day-olds does materially affect the working of such a holding, breeding pens and incubation being dispensed with, and attention simply concentrated on the rearing, fattening and marketing of the birds.

I gathered that Mr. Smith himself had returned from work in the city and that he had started his farm for the benefit of an only son. Mr. Smith certainly took an active interest in the place and with his boy, a lad of about 18, took charge of all the rearing. The fattening side of the business he—wisely I think—left in the hands of an experienced fattener. He told me he had a very great difficulty in getting a good man to satisfy him in the class of work turned out, but he thought he had at last succeeded. When I subsequently inspected the birds being packed for market, I think I agreed with him.

Marketing.

The whole of the work on this holding revolved around the intention to market 55 birds a day, 4 days a week, for 10 months of the year. This meant an output of some 9,460 fully-fattened 4 to 4½ lb. birds in the 10 months. Marketing was only done by Mr. Smith on 4 days a week, because, according to him, the best prices were not got on a Saturday market, and also it allowed Friday and Saturday for cleaning up. Neither was any killing done on Sundays for the Monday market. Since 220 birds were marketed each week, an intake of 250 day-olds were needed weekly, and this number allowed for a loss in rearing and unthrifty chicks of 12 per cent. All day olds purchased carried a guarantee that the parent stock had passed the agglutination test for B.W.D. and had a clean bill of health.

When they arrived, day-olds were housed in a large brooder house, where they remained for from 6 to 8 weeks, according to the weather, having access to a sun balcony from the first. Heat was obtained from oil-burning hovers. Dry-mash and a little grain was the system followed for feeding.

Just before leaving the brooder the chicks were culled, any unthrifty birds being destroyed. Mr. Smith said this saved a lot of disappointment and worry in the long run. He was very much against carrying what he called " passengers."

The arks I found were enclosed in good size runs, contrary to the practice on most places, but Mr. Smith felt quite satisfied with the plan, saying he did not find unrestricted range an unmixed blessing. Here also chicks were fed on dry-mash and grain.

At 14 weeks, exactly, birds came off grass to the fattening coops. Mr. Smith was very particular about this. They had to come away to the day, and none were allowed to remain on the score that they would benefit by another week on grass. He had tried the latter practice he said, in the early days, only to find himself eventually with a crowd of chicks encumbering the arks, of all ages, and of questionable utility.

Fattening coops were housed in open sheds, the latter provided with shutters which could be closed after feeding, putting the birds into semi-darkness, and inducing rest.

Feeding.

Here I was introduced to the fattener, a typical Sussex feeder, who, I was quick to see, knew his work. He informed me that he kept the birds on the trough for about a fortnight and then crammed for the next seven days. The feeding was on the usual lines, advocated in this book, viz., Sussex Ground Oats and milk for both trough and cramming, except that in the latter case mutton fat was added to the mixture. Here again I found no passengers were allowed, the whole of a particular batch of the same age having to go to market the same week. The fattener, in addition to feeding his birds, prepares the fattening mixture, keeps his shed cleaned out, does the plucking (by machine in this case) and does the packing for market. The only help he gets is from a couple of women who come up on market days for which they are paid piecework rates.

The finished bird on Mr. Smith's farm is 17

weeks old and I should say the average dead weight (i.e., minus feathers) is $4\frac{1}{2}$ lb. A good many of the birds scale 5 lb., but when pullets are used the weight is nearer 4 than 5 lb.

I was interested to see on this establishment birds being marketed in the non-returnable packages in dozen and half-dozen boxes. Any odd birds left over were sold locally without any trouble. These birds were beautifully finished and packed in a first-class manner. They all went to the wholesale market, and I felt they could, and would, hold their own with any consignments that might be coming in from abroad.

The Poultry Department of a General Farm.

It was with some hesitation that I rang up Mr. J. H. Berry of Crundale House Farm to enquire whether I might have the opportunity of looking over his poultry department. I knew that he was a very busy man, for he was engaged not only in working two large farms, but was also actively interested in various public affairs. Mr. Berry was, however, not only willing that I should see his poultry, but offered to accompany me round his farm, an offer of which I was glad to take full advantage. Crundale House Farm I found, comprised some 250 acres, of which 140 are arable, 20 acres fruit, 15 acres pasture, and 75 acres downland. The farm is situated in a dip of the North Downs and is about 200 feet above sea level.

Up-to-Date Lines.

I soon found that Mr. Berry, whilst professing to being no poultryman, was keenly interested in the poultry department, running it on up-to-date lines as a separate department, and requiring it to pay its way. Particularly emphatic I found him on the subject of keeping only the best, and to that end, he insisted on regular culling. At the end of the season, he went further, and called in a professional culler, for a final culling of the flock, with instructions to discard anything not of first-class quality. That being the policy, one would not be surprised to hear that I was able to see a first rate lot of birds. When we started out on our round Mr. Berry laughingly suggested I should keep my eyes skinned for dud birds, offering to put a contribution into the Red Cross Box for every questionable bird I could point out to him. I must confess that at the end of the afternoon I was not able to find the box any heavier as a result of the challenge.

Flock Mating.

The stock on the farm consists of Rhode Island Reds, and a beautiful lot of birds they were. The present head of stock is approximately 1,000. Incidentally, Mr. Berry says he may increase this to 2,000 but he will not go beyond that number. Of the number kept, about 200 are breeding hens which are kept pure. It was with legitimate pride that I was shown the Rhode Island Red cockerels bought in for the coming season's activities. Mr. Berry told me a friend, in whose judgment he had every confidence, bought these birds for him and that he had paid £5 for each of them. They were a nice bunch. Breeding is done on the flock mating system, one bird to some twenty hens. An extra bird is included at the commencement of the breeding season to allow for the hens remaining properly mated, if one falls out on the way. One feature I found at Crundale House Farm was of particular interest. Of about 800 pullets reared for egg production, some 600 are mated in their first season to Black Leghorn Cockerels, the eggs being sold for hatching. Mr. Berry pointed out that chicks hatched from this mating were not pures, and would not ultimately find their way into breeding pens, but would be used simply for egg production. I was informed that a ready sale was found for all eggs that came from this cross mating.

At present no incubation is done on the farm, all eggs being sent away for hatching. The day-olds are sexed and only pullet chicks returned for rearing, with the exception of a few cockerels which are included for rearing table-chicks for the house. The pullet chicks are intensively reared in a brooder house divided into six sections, each taking 100 chicks. The chicks are brooded under an oil-burning pyramid hover. Each section of the brooder house is effectively boarded off to prevent floor draughts. A sun parlour to allow the chicks to get into the fresh air and sun, is built on to the front of the house.

In the Orchards.

From this brooder house chicks are transferred to arks, placed as a rule in the orchards. I asked Mr. Berry whether he had ever had any trouble with his birds as the result of eating fallen fruit. He replied in the negative. The housing is on what may be termed the small-unit system. There are a few permanent houses on the pasture land, and these take up to 150 birds each. I noticed in these particular houses that the perches were placed at right angles to the back of the house. Underneath the dropping boards were nest boxes.

Slatted-floor houses were used in the orchards. A portable type of house was in use for taking the birds onto the stubble in the Autumn. Mr. Berry was very keen about this and said the whole of his stock was so transferred, the birds having to find all their food there as long as there were any gleanings to be had.

I was told that the whole of the stock was shut up at night, however far the birds might be from the farm buildings.

Mr. Berry informed me that blood testing was done regularly, every year.

Whilst the chicks were being brooded, the dry-mash system of feeding was used, but as soon as the growing stock went out onto range, it—

together with the adult birds—was fed on one wet-mash and one grain feed per day. I was interested, in view of experimental work in which I had been engaged, to find that the wet-mash had a good quantity of steamed potatoes in it. Mr. Berry informed me that the use of potatoes as an important part of the mash had been fully justified by the results he had obtained.

One Man Responsible.

One man was responsible for the whole of the poultry work, which, in addition to that already mentioned, includes rearing a few ducks and geese for the table. As is usually the case on the general farm, relief can be found when he is requiring a day off. Help is also forthcoming if houses have to be moved from one part of the farm to another, or anything should arise to demand assistance.

I left Crundale House Farm feeling what an advantage this system of poultry-keeping had over other methods. Plenty of sweet ground is available for birds, and they live under ideal conditions. As birds are on free range no wiring is necessary. The exercise the birds are able to obtain must make for good virile stock.

A Small Holding.

Up Among the Hills.

Mrs. Shan's small holding stands up among the hills about 500 feet above sea level. It is one of the prettiest, unspoiled parts of the country I know. On a clear day one can see the estuary, and when the wind is in the right direction, one can taste the salt breezes coming up from the sea. I say *Mrs.* Shan's holding, because Mr. Shan's work takes him away from home for the greater part of the day.

When I arrived one sunny morning, Mrs. Shan was busy making chutney. " I was hoping to call when you were not busy," I remarked. " Then you must come in the middle of the night! " she replied.

Woodlands Farm, as this little holding is called, comprises house, buildings, a good garden with some fruit trees and about ten acres of pasture.

A couple of cows and a heifer are kept; also when the opportunity arises, one or two bull calves, or a heifer calf, are brought along for market. The care of the cattle and growing stock are the province of Mr. Shan who also does the milking, before going off to his own work.

Several weaner pigs are bought in during the year and fattened, and it was with not a little pride that Mrs. Shan told me " They are killed, dressed, and smoked on the premises," and she held up for exhibition a nice piece of smoked bacon.

A few rabbits are bred and fattened for the table. Aylesbury ducks are hatched for the same purpose, and about a dozen turkeys are brought along for the Christmas market.

To inspect the poultry section was the main object of my visit to Woodlands Farm.

Management.

Mrs. Shan told me that she always tried to keep an average of 120 layers. I noticed that these were of the Plymouth Rock breed, and a very fine looking lot of birds they were. Housed in the ordinary type of small roosting house, fitted with nest boxes, there were about sixty in each house. They had the run of a five-acre meadow, where the cattle also grazed. Asked why she had chosen this particular breed, Mrs. Shan said she considered she got a good supply of nice eggs from them, they were very hardy, and also the cockerels made good table birds which she found no difficulty in selling. A corn feed which was broadcast in the grass was given to the birds when first let out. In the late afternoon a wet-mash made up of boiled wheat and a little maize is mixed with skim milk, being dried off with middlings. This is varied with a mash made up of potatoes and Sussex Ground Oats rubbed off with middlings. Skim milk is also added to the mash. About 150 chicks are reared annually by broody hens, which also hatch out the eggs. The hen is confined to the coop for a short while after hatching, but later she is let out to roam and forage with her youngsters. Mrs. Shan does not think it extraordinary to rear all the chicks hatched out; on the other hand she is perturbed if the losses amount to more than one or two. If possible all hatching is done in the month of March. Wet-mash consisting of Sussex Ground Oats and middlings mixed with skim milk is fed to these young chicks. Cracked wheat is also given as a corn feed.

Birds for the table and the Aylesbury ducks are given a mixture of boiled wheat and cracked maize to which skim milk is added, the whole being dried off with middlings.

Woodlands Farm being about seven miles from a town, it will be seen what a boon the Packing Station is in this case, for the van calls to collect the eggs every week, when, from what I saw, Mrs. Shan has a large box full for it.

A paddock of about three acres was, I noticed, put up for hay and a stack in which big inroads had already taken place stood in the farmyard. I was informed that no hay had been purchased for the stock for many years. " We really are busy in hay making time," Mrs. Shan observed. As one would expect, the pigs were being fattened in their stys, and the same care was taken in the preparation of their meals as was given to those got ready for the birds.

Before leaving Woodlands I was given a cup of tea, and sampled one of the Plymouth Rock eggs. The yolk was as rich as anyone could desire. On enquiry I found that the butter was home-made.

"How do you manage about shopping," I asked Mrs. Shan, "Well," she replied. "The grocer calls here about once a fortnight, and the baker a bit more frequently, but we see to it that we do not go short." "How long is your working day?" I ventured. "From daylight to dark," she replied. "And after that I clean the eggs." "Would you change the life if given the opportunity?" I queried. "Not for one minute," she protested. "I would not change it for anything. There is plenty to do I admit, but getting up, and going out in all weathers wet or fine, to see the stock, will keep anyone healthy, and you will have no need of the chemist's shop."

Stake in the Country.

I came away from Woodlands having seen much to think about. The night before, I had listened to a debate on the wireless which I thought suggested there should be no place in the future, for the small farm. Here was someone willing to work very hard, not wanting supervision or interference, knowing the work, and only wishing to be allowed to get a fair living for her exertions. We have heard in the past, and may do again, of bringing the Townsman to the land, and helping him to establish himself. Could not some help be extended to those already there, and who wish to remain? Could they not be given a stake in the country? In the past a good deal of our dairy produce and eggs came from the continent, from the land of peasant proprietorship. Is it beyond the bounds of possibility to establish something of the same sort in this country?

RECORDS

Keeping Records. The necessity for working to a system. Recording details of hatching, rearing, marketing and casualties. Some notes on keeping accounts.

Records.

The keeping of records is usually associated with the pedigree breeder who must know the life history of the birds on his holding, and the commercial man may well ask to be saved from adding it to his other multifarious duties. Far from adding to these duties however, it can be made the means of saving a lot of work and worry. A man may think he knows his holding in and out, just what numbers he has at one time, how many casualties he has sustained, say during the previous three months. It is suggested that without keeping some records, he may well find himself wide of the mark. Especially where table poultry are concerned, and hatching, rearing, fattening and marketing are carried on regularly week by week for perhaps ten months of the year, or even without a break, some check up is necessary. These birds will range from day old to about 18 weeks, and it is very easy for stock on a large holding of this description to have disappeared for some little time, before being discovered, if the loss is found out at all.

Simple Plan.

The writer, who has been concerned with table poultry for many years, devised what he considers a simple plan, to enable him to keep his finger on all the stock. By its use he was enabled to know just what he would be doing in any one week in the year, and could see his work for months ahead. The routine work such as cleaning out can be so arranged that it will not clash with a killing and marketing day. Care can be taken that no hatching takes place, or any shifting of chicks, has to be done on a Saturday, Sunday or Bank Holiday. The farmer can know just how many birds he will be marketing on any particular day, some time ahead; he will know the exact age of the batch to be sold, and if he is wise he will let the whole batch go and not carry over any passengers till they have grown a little more; these birds which are probably unthrifty, have a habit of being left too long for their own good, or the farmer's pocket, and they are better sold.

It is suggested that the plan set out below is capable with adjustment to suit any type of poultry farm. The Ground Plan would be better drawn out or painted on a sheet of plywood or some such material as it will have to be used constantly for pinning up tickets of identification in the appropriate squares.

Fig. 34 shows the rough plan of a simple Table Poultry holding, where no Breeding Stock is kept and hatching eggs are purchased regularly week by week. Two hundred eggs are purchased each week, a 65 per cent hatch is allowed for, and an outside figure of 20 per cent loss from deaths and culls in rearing estimated for the whole year. It will not of course always be as much as this.

Casualty Sheet (D) (to hang up near the Ground Plan of the Plant).

January	4th	1	(B.H.1.)
,,	6th	3	(B.H.1.)
February	9th	2	(B.H.2.)
,,	13th	1	(B.H.1.)
,,	16th	2	(B.H.3.)
,,	16th	1	(B.H.4.)
,,	17th	1	(C.O.1.)
,,	20th	1	(C.O.1.)
March	7th	1	(A.1.)
,,	8th	1	(A.2.) etc., etc.

B.H. = Brooder House
C.O. = Carry-on Section
A = Arks
F = Fattening Shed

Work Sheets (E) (assuming operations to start in January).

(1)

January	4th	Tues.	Batch	1 day olds
,,	11th	,,	,,	2 ,, ,,
,,	18th	,,	,,	3 ,, ,,
,,	25th	,,	,,	4 ,, ,,

(2)

February	1st	Tues.	Batch	5 day olds
		,,	,,	1 to carry on rearer
,,	8th	,,	,,	6 day olds
		,,	,,	2 carry on
,,	15th	,,	,,	7 day olds
		,,	,,	3 carry on
,,	22nd	,,	,,	8 day olds
		,,	,,	4 carry on
,,	29th	,,	,,	9 day olds
		,,	,,	5 carry on
		,,	,,	1 to arks

(3)

March	7th	Tues.	Batch	10 day olds
		,,	,,	6 to carry on
		,,	,,	2 to arks
,,	14th	,,	,,	11 day olds
		,,	,,	7 to carry on
		,,	,,	3 to arks
March	21st	Tues.	Batch	12 day olds
		,,	,,	8 to carry on
		,,	,,	4 to arks
,,	28th	,,	,,	13 day olds
		,,	,,	9 to carry on
		,,	,,	5 to arks

(4)

April	4th	Tues.	Batch	14 day olds

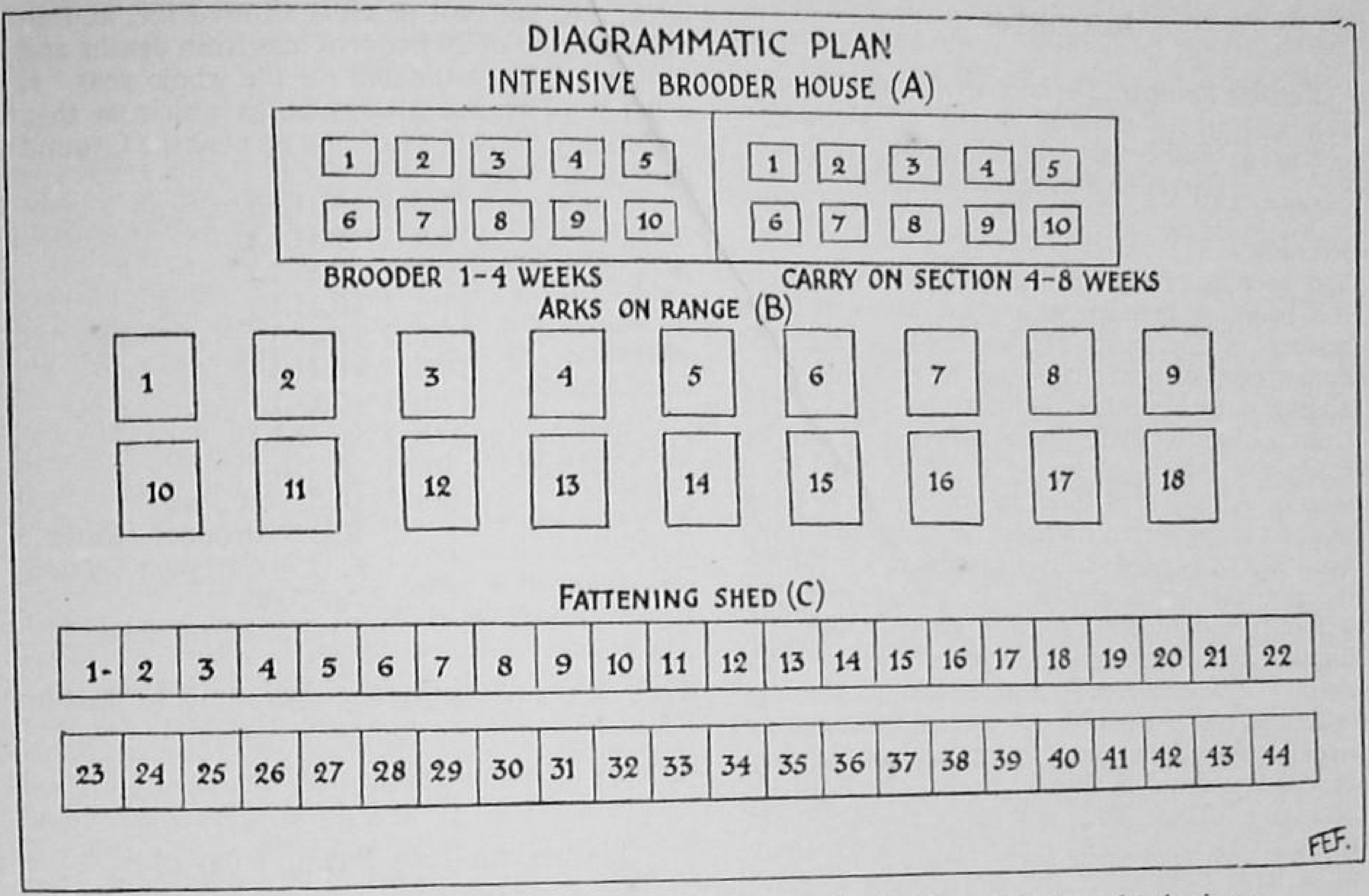


FIG. 34.—Working to a plan is as necessary on a poultry holding as in any other business.

April 4th Tues. Batch 10 carry on
,, ,, 6 to arks
,, 11th ,, ,, 15 day olds
,, ,, 11 to carry on
,, ,, 7 to arks
,, 18th ,, ,, 16 day olds
,, ,, 12 to carry on
,, ,, 8 to arks
,, 25th ,, ,, 17 day olds
,, ,, 13 to carry on
,, ,, 9 to arks
,, ,, 1 to fattening shed

(5)

May 2nd Tues. Batch 18 day olds
,, ,, 14 to carry on
,, ,, 10 to arks
,, ,, 2 to fattening shed
,, 9th ,, ,, 19 day olds
,, ,, 15 to carry on
,, ,, 11 to arks
,, ,, 3 to fattening shed
,, 16th ,, ,, 20 day olds
,, ,, 16 to carry on
,, ,, 12 to arks
,, ,, 4 to fattening shed
,, ,, 1 kill and market
May 23rd Tues. Batch 21 day olds
,, ,, 17 to carry on
,, ,, 13 to arks
,, ,, 5 to fattening shed
May 23rd ,, ,, 2 kill and market
,, 30th ,, ,, 22 day olds
,, ,, 18 to carry on
,, ,, 14 to arks
,, ,, 6 to fattening shed
,, ,, 3 kill and market

Working Sheets.

These working sheets should explain themselves, and they deal with three complete batches from day-old stage to killing. It will be noticed that Tuesday is the day in each week on which all work, i.e., moving birds from one section to another, and killing, is stated to take place. It is obvious that it cannot all be done in one day and the work sheet is merely a guide or reminder that in that particular week, all the work set out must be commenced on Tuesday and carried on until completed. Monday is left free for cleaning up after the week-end.

It will also be noticed in the work sheets that the birds are killed after three weeks fattening when 19 weeks old. This is subject to adjustment and can be carried out after two weeks conditioning, if it is considered the birds are ripe for marketing.

From the work sheets the ground plan is made up every time birds are moved. Take the date May 2nd for instance. The 18th batch of day-olds has come in and will go into the brooder house and into brooders 7 and 8. A small ticket marked (B. 18, May 2nd, 70) will be pinned on to square 7, and a similar one on to square 8. It is best to

leave the number 70 in pencil. The ticket for batch 14 will be removed from numbers 9 and 10 brooders and put in to squares 5 and 10 in the carry on. Likewise, for batch 10 the tickets will be removed from carry-on to arks and those for batch 2 from arks to fattening sheds. At each stage tickets will be adjusted for numbers from Casualty Sheet D.

Simple System.

It is hoped this plan does not look formidable. It is really very simple, and the writer has found boys able to keep it accurately. It is a system that has saved any amount of worry and trouble, which one is very liable to run into where thousands of small birds are scattered round a holding. It is so very easy to lose birds without some check. Working on this plan it is of course necessary that all brooders, carry on rearers, arks and cages shall be plainly numbered. Paint should be used or metal numbers, as chalk is easily obliterated.

Transactions.

Every poultry farmer should keep a set of books in which are recorded all his transactions during the year. Not only is it business-like to do so, but well-kept accounts can be the means of being able to place one's finger on the weak and unprofitable spots and getting them altered before it is too late. Nor need there be any difficulty in the matter, for it can be done in a very simple way. Nothing elaborate is needed. For those who know nothing about book-keeping there is A. C. Campbell's " Good Farm Accounting," in this series of books. There is set out, in sufficient detail, all that the good poultry farmer is likely to need in keeping his accounts.

It is usual for books to be kept for a complete period of 12 months. Just when one should start depends on the circumstances. If a new holding is being taken over, then accounts should start at the same time. Should one have been poultry farming for some time and kept no books, then a start can be made on, say, January 1st, or some people would prefer Michaelmas Day.

Briefly what one would want to ascertain is the profit made in the year, if any. Now profit does not mean just cash, but also includes any increase in stock there may be at the end of the year. The farmer will also want to know how much he has paid out for feeding stuff, wages if any, purchase of stock and so on. In addition there will have to be a record kept to ascertain if he is owed more or less at the end of the year than at the beginning, likewise whether he himself owes more or less than he did a year previously.

Inventory and Valuation.

Therefore at the beginning of a tenancy, or when commencing to keep a set of accounts, an inventory and valuation of everything on the holding, which belongs to the poultry farmer, should be made. This will include birds, implements, appliances, housing (if owned by the poultry farmer), any eggs in stock, and also any feeding stuffs and other useful goods in hand. These should all be priced at what they cost, with the eggs at market value. At the same time should be made out a list of debts connected with the farm owing by the farmer, and a list of farm debts owing to him.

During the year a cash book should be kept in which are recorded all farm receipts and payments. It must not contain any private transactions.

At the end of the year another inventory will have to be made, similar to the first one, but with this difference. Any increase in live stock which has been bred on the farm should not be included at market value, but rather at a fair value. By this is meant a value which will not be affected to any extent by a rapid fluctuation in prices. The reason for this is obvious. Should prices for some reason have soared highly during the year, then a good profit will be shown, but it will only be a paper one, for the stock will most probably be kept on for another year, or at least a good proportion of it. If the market value is taken and prices fall in the following year, then a loss will be shown, which again will be a paper one. Far better keep a fair price fixed and use the same figure each year. Matters will adjust themselves when stock is sold at market value, and any profit shown will at least be a real one.

Also in this valuation at the end of a year's working, implements and appliances will have been used for a year. If they were purchased new, and only used a very little, they will still be second-hand. They too are most probably going to be kept on the holding, and a fair way to deal with them is to depreciate them to the extent of say 10 per cent at the end of each working year. Perhaps some things will be better depreciated at a little higher figure, and on the other hand some a little less. Whatever figure is decided upon should be used each year.

Farm Debts.

In addition to the inventory and valuation of the farm at the end of the year, a list will have to be prepared showing farm debts owing by the farmer, likewise a list of farm debts owing to him. Now the difference between the valuation at the end of the year and that taken at the commencement of the year will show part of the profit on the farm, providing the second valuation is higher than the first. The profit will also be affected by the difference between the debts due and owing to the farm at the beginning of the year, as compared with those at the end of the year.

Finally the difference between money received from sales of produce and money spent out on things for the farm will give the remaining profit, provided the receipts are higher than the payments.

If all these three items which represent *profit* are added together, the *total profit* for the year is obtained.

It must not be forgotten that any produce, eggs and the like, used by the farmer's household, must be paid for to the farm. Account should be kept of all small payments made in cash by the farmer. These are known as petty cash payments and should be debited say once a month to the appropriate accounts. Often cash columns in the pocket book are used for the purpose of keeping track of these small payments.

The simpler these accounts are kept the better, but it is well worth while to keep them and they need not take up too much time of the poultryman's working day.

STATEMENT OF ACCOUNT

		£ s. d.		£ s. d.
To Valuation at Michaelmas, 1944 ...		1,000 0 0	By Sundry Receipts (Money received by Farm)	650 0 0
,, Sundry Payments by Farm	£430 0 0		,, Poultry and Eggs used in House ...	20 0 0
,, Sundry Payments by Petty Cash ...	20 0 0			670 0 0
,, Wages of Daughter	45 0 0		,, Valuation at Michaelmas, 1945 ...	1,300 0 0
		495 0 0		1,970 0 0
		1,495 0 0		
Add Sundry Creditors at Michaelmas, 1945 (Money owing by Farm)		32 0 0	*Add* Sundry Debtors at Michaelmas, 1945 (Money owing to Farm)...	49 0 0
		1,527 0 0		2,019 0 0
Less Sundry Creditors at Michaelmas, 1944		40 0 0	*Less* Sundry Debtors at Michaelmas, 1944	50 0 0
		1,487 0 0		
PROFIT FOR YEAR		482 0 0		
		£1,969 0 0	...	£1,969 0 0

NOTE.—Futher analysis of receipts and payments can be made to suit individual cases.

LITERATURE OF GOOD POULTRY KEEPING

The following important publications will be of great use to the good poultry keeper.

HALNAN, E. T. *The Scientific Principles of Poultry Feeding*. Bulletin No. 7 (Ministry of Agriculture).

PUNNETT, R. C. *The Sex-linked method in Poultry Breeding*. Bulletin No. 38 (Ministry of Agriculture).

MOLYNEUX, H. *The Culling of Poultry*. Bulletin No. 59 (Ministry of Agriculture).

MORLEY, A. JULL *Poultry Husbandry*. McGraw-Hill Book Company Inc., New York and London.

RICE & BOTSFORD *Practical Poultry Management*. John Wiley & Sons, New York.

GLOSSARY

Barred. A term used where feathers carry alternate stripes of light and dark colouring. This is best seen in the Barred Plymouth Rock.

Bloom. The sheen or glossy appearance on the feathers.

Brassy. Yellow tinted. Found often in breeds like the White Wyandotte.

Breed. The race or class of fowls.

Capon. A castrated male bird.

Comb. The red fleshy protrusion on the top of the head. Combs differ in different breeds as single (Leghorn), rose (Wyandotte), leaf (Houdan), pea (Game).

Condition. The health of the bird; its general appearance.

Crest. A tuft of feathers on the head (Houdan breed), also known as " Top Knot."

Cushion. Term usually applied to the female bird, and refers to the feathers at the back and under the tail.

Cross Bred. The result of mating two distinct breeds together.

Dewlap. The gullet. Can be seen plainly in adult geese.

Dubbing. A term generally used for the cutting off the comb of single comb male birds.

Ear Lobes. The folds of skin hanging from the ears. The lobes differ in different cases in size, shape and colour. They are mostly cream, red or white.

Feathered Legged. A term used where birds have feathers on the shanks (Faverolles).

Flights. The primary or long feathers of the wings. Used for flying, they are tucked out of sight when the wing is folded.

Fluff. The first feathers on a chicken. Also the soft downy feathers about the thighs of the adult bird.

Frizzled. A term used for curled feathers.

Hen. Usually used to denote a bird that has completed its first laying season.

Hackles. The narrow feathers growing on the neck. They are usually long and pointed. In the case of the male bird they can be seen on the saddle, and are known as saddle hackles.

Hock. The joint of the thigh with the shank, sometimes called the knee joint.

Horn Comb. A comb that is V-shaped (La Fleche breed).

In-Breeding. Breeding from related parents.

Keel. The vertical part of the breast bone.

Knock Kneed. Term used of birds which have their hocks near together instead of well apart.

Lacing. An edging round a feather.

Leaf Comb. A peculiar shaped comb seen to best advantage in the Houdan breed.

Mottling. Spots of colour at the end of the feathers, as in the Ancona.

Muff. Feathers on each side of the face (see Faverolles).

Pea Comb. A kind of double comb.

Pencilling. Markings or stripes straight across or round a feather.

Primaries. See Flights.

Pullet. A term used for a bird in its first laying season. It remains a pullet until the first laying season is completed.

Rose Comb. A broad comb, nearly flat on top, as seen in the Wyandotte breed.

Saddle. The posterior part of the back reaching to the tail of the cock.

Secondaries. The long quill feathers of the wings, which can be seen when the wings are closed.

Self Colour. One colour, not mixed with any other.

Shaft. The quill part of the feather.

Shanks. The part of the leg below the hock.

Sheen. The bright gloss on feathers.

Sickles. The long curved feathers of a cock's tail.

Single Comb. A narrow comb having serrations and spikes, as seen in the Leghorn.

Spangling. Large spots of colour on the feathers different from that of the ground colour.

Spur. Horny substances growing from the shanks of the male bird near the heel. Occasionally hens will develop spurs.

Squirrel Tail. A tail which is carried high, bending over the back like that of a squirrel.

Sprigs. Small spikes on the side of a single comb. It is considered a defect.

Stag. A male turkey after reaching the adult stage.

Strain. A line of birds which have been specially bred, and in which some definite characteristic has been fixed.

Strawberry Comb. A comb that somewhat resembles a strawberry.

Tail Coverts. The curved feathers at the side of the lower part of the tail.

Tail Feathers. The long, straight and stiff feathers of the tail.

Thigh. The part of the leg above the hock and covered with feathers.

Type. All the parts of the fowl taken as a whole, and being in harmony, typical of the variety it represents.

Under Colour. The colour at the root of the feathers. The soft down or fluff that is seen when the bird is handled and examined.

Variety. The division of a breed known by its colour or markings. Wyandottes and Leghorns are examples.

Wattles. The flesh-like skin at each side of the base of the beak. The wattles are chiefly developed in the male bird.

Web. The skin between the toes, or the skin seen when the wings are extended.

Wing Bars. The two lines of short stiff feathers on the wing, covering the roots of the longer wing feathers.

Wing Coverts. The feathers covering the roots of the secondary feathers.

Wry Tail. A tail carried to one side, and not straight with the body of the fowl.

SOME USEFUL NOTES

How to hold a fowl when administering medicine. Take the fowl up and place it under the left arm, getting it well up, so that it is held by the upper arm and elbow. With the left hand that has been left free, open the mouth of the bird, and administer the medicine with the right hand. If the left foot is raised on a box whilst carrying this out, the job will be easier to perform.

Disposing of a dead bird. Always burn a diseased bird. It is much more satisfactory than burying it. A small amount of paraffin poured over the carcase will facilitate and make a clean job of the work. A home-made incinerator built either of bricks, or an old drum pierced in several places to create a draught is a useful adjunct to the poultry farm.

A hospital coop, cage, or small house, should be available on any poultry holding. If a fowl should appear to be unwell, take her away from the other birds, and isolate her for a few days. If it should turn out that she is suffering from an infectious disease, there will at least have been some attempt to save the other birds. Keep the hospital well away from the poultry houses, and see that it is kept absolutely clean and disinfected.

A medicine chest should be kept handy. Whilst it should always be the practice to destroy any bird that is obviously ill, unless there is some good reason for keeping it, there are occasions when a simple ailment or complaint can be quickly put right if the necessary medicines are to hand. The following might well comprise the medicine chest:—Permanganate of Potash, Sulphate of Copper, Sulphate of Iron, Castor Oil, Epsom Slats, Vaseline.

The Permanganate, really a disinfectant, is generally used for "pinking" the water, if the weather is very changeable, or a cold is suspected. The permanganate crystals should be put into a bottle and water added to it. The solution which will then have a dark purple appearance, should be added to the drinking water until it just turns pink. Permanganate given this way is harmless. It is also useful in cleansing a wound caused by a rusty nail or piece of wire.

Sulphate of Copper added—in a small quantity for it is a poison—to the drinking water is also a safeguard if colds are suspected. Do not use galvanized troughs.

Sulphate of Iron enough to cover a sixpence added to the trough of drinking water acts as a tonic where birds are in a poor condition.

Castor Oil and Epsom Salts should not be given to fowls as a matter of routine, as is sometimes done, but should be kept for use when really necessary.

Vaseline for applying to wounds of any description is a useful stand-by.

A lighted candle or match will discover a draught, but care must be taken in their use if litter is lying about.

A Box kept in the laying-house will be found useful for storing eggs during the day-time before the final collection is taken away in the late afternoon. Where trap-nesting is done, this is a necessity, but it is always advisable to remove eggs from the nest when possible. Leaving them lying around encourages egg eating.

Nests are better placed under the windows. The darker the position the better.

Galvanized Corn or Mash bins may be placed in each laying house if available, or in every alternate house. They save a lot of unnecessary tramping about, and can be refilled when food is being taken out all round the farm.

A Mincing Machine, the ordinary domestic machine, is a useful addition to the poultry plant, where only a few fowls are kept. House scraps and spare vegetables can be minced and will form quite a useful addition to the rations, with a saving in the food bill.

An Inverted jam jar in a saucer makes an excellent drinking fountain for young chicks.

Wire Netting for runs should be 5 ft. or 6 ft. high, 2-inch mesh, and 18 gauge if intended for fencing adult birds. For chicken runs, one inch mesh, two or three feet in height and 18 gauge is advised.

Posts for fencing may be of Chestnut, Ash or Oak. They should be dipped (treated with tar or creososte) before use and should be driven one foot or 18 inches into the ground.

Imported Deal, Larch, or Spruce Poles are very satisfactory for the best frame work in making Poultry houses. Uprights and horizontals should be 2 inches by 2 inches. For the large

type of house the uprights should be 2 inches by 3 inches, and about 3 feet apart.

Boarding for the walls may be either tongued and grooved match-boarding, or weather-boarding.

Roofing should be of ¾ inch wood covered with a good make of roofing felt.

Roofs may be either of the lean-to or the gable type. Rafters for the former type run from 2 inches by 2 inches to 2 inches by 4 inches, according to the span, and in the gable type of house from 2 inches by 4 inches to 2½ inches by 6 inches.

Felt is sold in rolls. Usually these are some 36 inches wide by 12 yards long. Allowing for the necessary overlap of 3 inches a roll should cover about 120 square feet.

Corrugated Iron, which is sometimes used for roofing poultry houses, will make for extremes of temperature, very cold in winter and hot in summer, unless it has an inner lining of boarding or straw. The latter will get verminous if a watch is not kept upon it.

A Thatch Roof is excellent for maintaining an equal temperature. For that reason it will often be used for roofing an incubation room. As stated above, it tends to harbour insects.

Earth Floors are inexpensive, but are not so much used as formerly. Even if built up above the surrounding ground, and well rammed, they still tend to get worked into holes by the continual scratching of the birds.

Wooden Floor Boards (tongued and grooved) should be at least 1 inch thick, the floor being supported on suitable joists 4 inches by 2 inches and sleepers 4 feet apart.

A Concrete Floor is too cold for a laying house. It must be very thickly bedded down if used.

To Prevent Whitewash Rubbing Off add size. The proportion is about ¼ lb. of size to each 2 gallons. These should be mixed whilst hot.

Allow One Pound of paint per 25 square feet of wood to be painted. Two thin coats are better than one thick one. After the first two coats allow one half pound per 25 square feet for subsequent work.

Floor and Air Space Required per Bird.

Kind of House	*Floor Space per Bird* Sq. Ft.	*Air Space per Bird* Cubic Ft.
Breeding House	2	12
Intensive House	6	36
Semi-intensive House	4	24
Roosting Shed with Scratching Shed attached	2 and 4	12 and 24
Backyard Poultry House	2	10
Backyard Run	20	—
Duck House	4	16
Goose House	6	36
Turkey House	8	60

Birds to the Acre System.	*Number to the Acre*
Free Range	25 to 50
Colony	200 to 300
Semi-intensive	150 to 200
Breeding Pens (with alternate runs)	80 to 100

Pullets are birds up to 12 months old.

Yearlings are birds from 12 to 24 months old.

Hens are birds over 24 months old.

Timber can be bought in different widths but is always sold by the square of 100 square feet. Boarding 4 inches wide will contain 300 feet run in 100 square feet. Boarding 8 inches wide will contain 150 feet run in 100 square feet. Boarding 12 inches wide will contain 100 feet run in 100 square feet.

One pint of water weights 1¼ lb.

One Truss of Straw weights 36 lb.

One Truss of Old Hay weighs 56 lb.

One Truss of New Hay weighs 60 lb.

36 *Trusses*—one load.

One Load of Straw—11¼ cwt.

One Load of Old Hay—18 cwt.

One Load of New Hay—19¼ cwt.

One Acre—4,840 square yards.

A Great Hundred of Eggs—120.

One Gallon of Flour—7 lb.

Freezing Point—32° Fahrenheit, 0° Centigrade, 0° Reaumur.

Boiling Point—212° Fahrenheit, 100° Centigrade, 80° Reaumur.

A Tablespoonful holds approximately ½ oz. liquid or 1 oz. solid.

A Desertspoon holds approximately ¼ oz. liquid or ½ oz. solid.

A Teaspoon holds approximately ⅛ oz. liquid or ¼ oz. solid.

Old Hens will make good prices if sold alive in the local markets at certain times of the year. These periods come in March-April, June and September. Local auctioneers will advise as to the exact days on which birds should be marketed.

Preserving Eggs. The best way known of preserving eggs is by the use of waterglass. Pure water should be boiled and one gallon mixed with one pound of waterglass. This mixture, which is enough for 100 eggs, must be allowed to cool before use. The eggs to be preserved must be new laid, and by this meant eggs between 2 and 4 days old, not warm eggs fresh from the nest. The eggs must be clean, and if necessary wiped with a damp cloth and then dried. Eggs with cracked shells must not be used. Thin shelled eggs will absorb the waterglass causing the egg to go bad, and affect the other eggs. If the solution is too strong the eggs will float and more water must be added. If, sometime after the eggs have been put down, one is seen to float, it should be removed, as it is probably not keeping. Use a pail or crock and pack the eggs carefully into it, the pointed end downwards. Then pour the solution over the eggs and see that the top layer of them is well covered. The solution should

come a few inches above the top layer of eggs to allow for evaporation. Cover the receptacle to keep out the dust, but do not make it airtight. examine the eggs from time to time and if the level of the liquid has fallen add cold water. This method is cheap, simple and effective. It is generally said that eggs will keep for 12 months when treated in this way. It has, however, been found that they will keep for well over that time, up to two years.

The Poultryman may be told sometime to give a dose of medicine of a certain strength, or so much of a certain solution of anything. If a 10 per cent solution is ordered, it means that of 100 parts of the mixture when made up, 10 parts are of the medicine ordered. To prepare a 10 per cent solution, put 10 ozs. of the medicine into a pint measure and fill the measure up with water. Pour the whole into a basin. Now a pint measure will take 20 ozs. of the liquid so the mixture so far is 10 ozs. medicine and 10 ozs. water. Add 4 more pints of water, totalling another 80 ozs., and you have 10 ozs. medicine in 90 parts of water or a 10 per cent solution.

To make up a 10 per cent solution of a solid substance, weigh out two ounces of the solid and place in a glass pint-measure with some water. Stir until the solid is dissolved, then fill up to the pint-mark with water.

Dead Weight. A term used in respect of a bird that has been killed and all feathers and stubs removed. In this condition fowls are sold in the wholesale markets, though some firms will also take the birds alive and make a charge for killing and plucking.

Birds weighing Live-weight 4 lb. Weight of feathers 4¾ ozs.

Birds weighing Live-weight 5 lb. Weight of feathers 6 ozs.

Birds weighing Live-weight 6 lb. Weight of feathers 6 ozs.

To Dress a Fowl. This will involve two operations, drawing and trussing. First deal with the sinews. Make a cut across the shanks in front, down to the bone, bending the feet over until the shank bone breaks. Tie a strong piece of string or wire around the shank just above the foot and attach this to a hook in the door post or wall. Hold the bird securely and pull the leg down. The foot and sinews will be left hanging.

Next take off the head and neck. Place the bird breast downwards cut up the skin at the back of the neck from the shoulders. Draw the skin back and cut through the neck joint close to the shoulders, so as to leave no neck-bone showing. Do not, however, cut through the skin on the lower side, as this will be required as a flap to cover the stump of neck remaining. The neck can now easily be pulled away and should be put aside as part of the giblets. Remove the head, cut off the remnants of wind pipe as far in as possible, and also remove the crop from the surrounding flesh.

Before leaving this part of the bird, introduce a forefinger into the cavity, working it round and loosening the organs as far as possible

Now turn the bird over, and make a slit with a sharp knife between the "parson's nose," or tail joint, and the vent. This must be done carefully so as not to rupture the intestines. Pass

Weights of Three Chickens at Different Stages of Preparation for Table (Rhode Island Red × Light Sussex) (lbs. and ozs.).

Dead Weight lbs. ozs.	Head & Feet	Indedible Offal.	Giblets.	Empty carcase. lbs. ozs.	Carcase after cooking. lbs. ozs.	Bones.	Flesh edible. lbs. ozs.
2–12¼	5¼ ozs.	5 ozs.	4 ozs.	1–14	1–10	8½ ozs.	1–1½
3–13½	7½ ,,	6½ ,,	5½ ,,	2–10	2–5	14 ,,	1–7
4–2¾	8½ ,,	4½ ,,	6½ ,,	2–15¼	2–8	11 ,,	1–13

Dressed Weight. A bird is usually sold dressed weight to retail customers and occasionally to the shops and restaurants. In this case the bird is plucked and all offal removed, i.e. head, feet, intestines, etc. The edible offal, i.e. those parts known as the giblets—gizzard, liver, heart and neck—are included in the weight of the dressed carcase. The following figures show the approximate amount of feathers in respect of birds of various weights.

Birds weighing Live-weight 2 lb. Weight of feathers, 2½ ozs.

Birds weighing Live-weight 3 lb. Weight of feathers 4 ozs.

the forefinger through this slit and loosen the intestines. Then with two or three fingers feel for the gizzard, and grasping it pull steadily. If the loosening has been done properly, the gizzard, liver, gall bladder and intestines will all come out together. The lungs which are close up to the backbone will probably have to be removed afterwards.

For Trussing. A trussing needle about ten inches long and some string will be needed. There are several ways of doing this. A simple way, easily followed, is this:

Place the bird on its back with the vent towards the operator. Press the legs well down, then

pass the needle through the thigh, right through the body, and through the second thigh. Turn the bird over and turn or twist the pinions inwards so as to point towards each other over the back. Now pass the needle through the wing bone near the centre, through the flap of skin covering the neck cavity, picking up the skin on the back at the same time, and finally through the second wing. Tie to the end of the string left loose.

Thread the needle again, pass through the leg joint above the hock through the skin at the end of the keel bone and through the other leg. Take both ends of string, cross and tie around the "parson's nose," drawing the legs down as the knot is tied.

SECTION VI

GOOD CONTROL OF PLANT DISEASES

by

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INTRODUCTION

EVERY housewife expects to find among the vegetables and fruit in her store, an occasional potato which " cuts black," an onion which is rotting, or an apple which is scabbed. These troubled potato tubers, onions and the apples are living organisms; all are breathing, and in due season the potatoes and onions, if healthy enough, will show more obvious signs of life by producing green shoots, while the pips of the apple are seeds which may develop into trees. But each is showing symptoms of disease and although infection probably occurred before they were harvested, the diseases are still causing damage while in the store.

On the farm or in the garden, how often is it that the vegetable or the fruit crop has not yielded well in spite of long hours spent in cultivating, weeding and manuring. These disappointing results may, of course, be due to the attentions of slugs, caterpillars or greenflies. In cases where the potato foliage has blackened and died prematurely, and there are small and perhaps rotten tubers, or cauliflowers have developed mottled leaves and produced curds no larger than billiard balls, the explanation is not so clear. More serious still, a cherry tree which had faithfully been bearing succulent fruit for twenty years has suddenly died just when a bumper crop was promised. In his daily tour of inspection, the puzzled farmer, as likely as not, has found no unusual number of insect pests or other forms of animal life to which he might attribute the blame. In fact, it is almost a certainty that all three troubles are due to disease.

The reader will note that a distinction has been made between disease on the one hand and damage done by animals, including insects, on the other. This division of plant disorders into two broad groups is a convenient one which has long been accepted in agricultural science and, except where insects are responsible for spreading disease, mention of them has been omitted from our discourse.

PLANT DISEASES IN HISTORY.

References to plant diseases are not infrequent in ancient writings although the causes were more often attributed directly to Divine displeasure than to more material agents. The word " mildew " occurs more than once in the Old Testament as, for example, in I Kings, viii. 37, where it evidently refers to a disease of crops: " If there be in the land famine, if there be pestilence, blasting, mildew, locust, or if there be caterpillar. . . ." A number of the early Greek philosophers made keen observations on plant life. One of these, Theophrastus, who lived about 300 B.C., was particularly interested in disease and may sometimes have arrived near the truth. Thus, he notes that " The olive, in addition to having worms (which destroy the fig too, by breeding in it), produces also a knot (*which some call a fungus*, others a bark blister). . . ."

He also writes of cereal " rusts " which are one of the most familiar diseases on the farm today. The Roman philosophers, in their turn, did not overlook these problems but they made no advance on the observations of the Greeks, tending more than ever to regard epidemics with a superstitious fatalism and attempting to control them by intercession with the gods. There was, among others, the festival of Robigalia, celebrated on the 24th of April, to placate the god, Robigus, who was supposed to have the power of regulating the annual severity of rust diseases in the cornfields.

In early times and until the beginning of the eighteenth century, interest was concentrated mainly on what had been written in the classics. Although more enterprise was shown by thinkers of the eighteenth and the first part of the nineteenth centuries, when attempts were made to classify diseases, there was the handicap that the true causes were not appreciated. It was, for instance, a point for debate whether a mould or mildew on the diseased part of a plant was caused by the disease or whether the disease was caused by the mould. Not until the beginning of the second half of the nineteenth century were living organisms acknowledged as a direct cause of plant diseases. Investigational work had been spurred on by the great Potato Blight epidemics which visited Europe and North America and which, by rotting the potato crops, were the cause of the great famine in Ireland where potatoes had become the staple food. The climax of devastation was reached in the years 1845 and 1846. The history of the famine and the steps followed by the investigators in their pursuit of the true cause and the cure, has been admirably presented in some detail by E. C. Large (1940) in *The Advance of the Fungi*. By 1863, DeBary had proved beyond doubt that Potato Blight was caused by a minute living organism which invaded both the foliage and the tubers of the plant. This minute organism, which can only be seen within the plant tissue by means of a powerful microscope, was identified as a fungus (plural *fungi*); and since the time of DeBary, fungi have been proved to be one of the main causes of plant disease.

The Irish famine is a grim illustration of how important is a knowledge of the prevention and cure of disease in crop plants. Here, a tiny fungus was responsible for mass starvation and death, and this, together with the resulting waves of migration, led to a reduction in the population of Ireland from eight millions to five within two generations. It is remarkable to think that had Bordeaux mixture, the spray which protects potato leaves from the disease, been known some forty years before it was actually discovered, the course of modern history might well have been different.

Such catastrophes as the Irish famine do indeed focus attention on the importance of certain fungus diseases and the necessity for their control. Even today, with the aid of all that modern agricultural science has to offer, the economic losses caused by diseases in crops are enormous. Thus, for instance, it has been estimated by the United States Department of Agriculture that "approximately one bean in every dozen, one peach in every eight, one bushel of (Irish) potatoes in every twelve, and one bushel of wheat in every ten are destroyed annually by disease in these crops." In addition to direct loss it must be remembered that much of the crop which is harvested may have inferior keeping qualities or show disfigurement due to a disease.

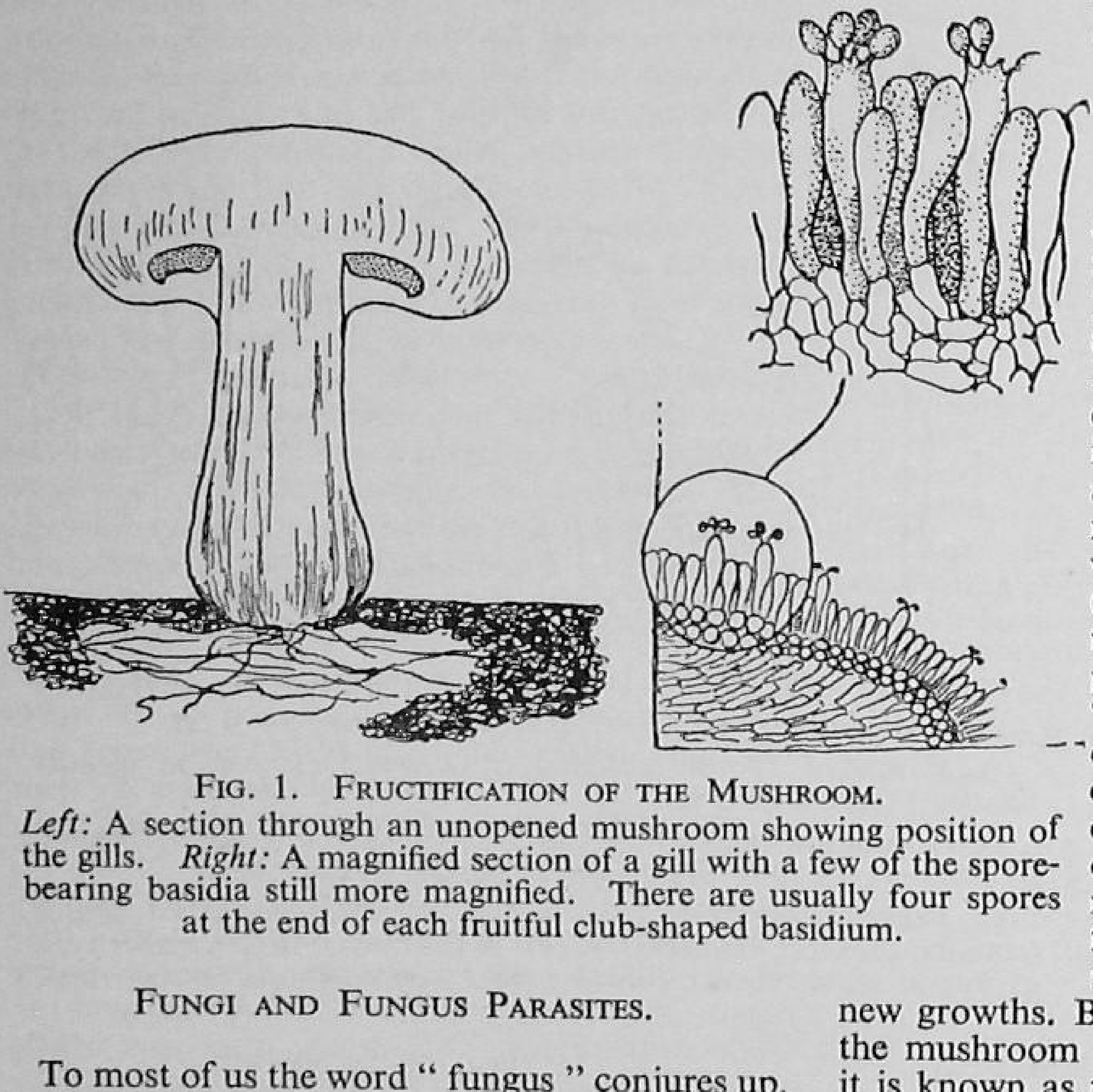

FIG. 1. FRUCTIFICATION OF THE MUSHROOM.
Left: A section through an unopened mushroom showing position of the gills. *Right:* A magnified section of a gill with a few of the spore-bearing basidia still more magnified. There are usually four spores at the end of each fruitful club-shaped basidium.

FUNGI AND FUNGUS PARASITES.

To most of us the word "fungus" conjures up, in the mind's eye, the picture of a mushroom or toadstool and, indeed, these are types of fungi. There is, however, an exceedingly wide range of these complex organisms, a large proportion of which are too small to be seen with the naked eye. Some 37,000 different kinds (species) of fungus have so far been recognized and new ones are continually being discovered. It is the task of a specialist to find out the relationships among them and to place each within the group which contains others most like it. We will leave the patient specialist to his task, but as fungi cause so many of the diseases of plants and are, therefore, very important in relation to our present theme, it would be well to explain a few of their commonest festures.

The fungi are members of the Plant Kingdom but an important difference between them and other members, such as flowering plants, ferns and pond weeds, is that they contain no chlorophyll. Now chlorophyll is the familiar green colouring matter of leaves which enables plants possessing it to use the carbon dioxide of the atmosphere to combine with other substances and form the tissue or "flesh" from which they are constructed. As fungi have none of this green pigment they cannot use the carbon dioxide of the atmosphere to build up their tissues but instead they *parasitize* other forms of life or feed on the products of their decay. As examples, the Blight fungus, a *parasite*, *parasitizes* the living potato plant (*the host*), while the mould growing on stale bread is a fungus thriving on a non-living plant product and is called a *saprophyte*.

THE MUSHROOM.

Most green plants possess leaves and roots which are concerned mainly with nutrition, they also produce flowers and seeds which are important in reproduction. Fungi also have specialized parts each with its own functions. For instance, as everybody knows, the above-ground part of a mushroom consists of a stalk and a cap with pink gills on the underside (Fig. 1). If the cap is removed from the stalk, and laid on white paper for a few hours, a brown "dust" will be seen to have been deposited from the margins of of the gills. Each minute speck of this "dust" is a *spore*, myriads of which are produced by a single mushroom. As with the seeds of flowering plants some of these spores may germinate to form new growths. Because the above-ground part of the mushroom is concerned with reproduction, it is known as the *fructification* or *fruiting-body*.

The spores either fall to the ground in the vicinity or are borne away by the wind to fall upon fresh soil. If we were to watch the germination of one of these minute, oval brown spores under a microscope, we should see a small tubular thread develop from it. If the spore had fallen onto suitable ground the thread (*hypha*) would have penetrated it and during the following months would have grown slowly through the soil, at the same time branching profusely and obtaining nourishment from the decayed vegetable and animal matter beneath the turf. The mass of white, blanched threads (*hyphae*) formed from this single spore, known as a *mycelium*, is not always easy to distinguish beneath turf, but it may be seen in large quantities as a white cottony growth in the beds of mushroom houses

where it is popularly known as *spawn*. Under suitable conditions of moisture and temperature, the mushroom mycelium will bunch together to form the above-ground fructification and so begin the cycle once again.

Variations Among Fungi.

The parts of a mushroom and their functions have been described because it is a fungus with which most of us are familiar. Nearly all fungi which attack plants have corresponding parts with similar functions, but there are great variations in size and appearance (Fig. 2). Instead of penetrating the soil, the hyphae may penetrate the living tissue of a host. Spores are then produced, but are mostly connected with microscopic fructifications of which there are numerous diverse shapes. For example, many parasitic fungi closely resemble the mildew which is seen on damp bread and, like this mildew, produce spores at the ends of threads which form in colonies on the surface as a downy growth.

Bacterial Diseases.

Research on fungus diseases was well advanced before it was shown that *bacteria* could also cause disease in plants. That these organisms, smaller even than the fungus spores of Potato Blight, could cause illness in man and animals had already been established for some years when Burrill of the U.S. Department of Agriculture showed in 1880 that Fire Blight, a disease of pears, was the result of infection by bacteria. From then onwards real progress was made. The late Erwin F. Smith, also of the U.S. Department of Agriculture, was the outstanding pioneer in laying the foundation of Plant Bacteriology. As early in his researches as 1896 he felt able to state that " there are in all probability as many bacterial diseases of plants as of animals." It cannot be claimed, however, that bacteria rank in importance with fungi or with viruses as agents of disease in plants.

At the present time there are about 100 species of described bacteria known to be responsible for plant diseases and many others are suspected. Among the better known of these are some of the soft rots of fruit and vegetables and the galls on the stems of certain plants. Also prominent is Bacterial Canker of tomatoes, a disease which has caused great losses in America and in parts of Europe for many years but which was not recorded in Great Britain until 1943. Bacterial Canker of cherry and plum trees is also a well-known scourge in Kentish orchards.

Sizes and Shapes of Bacteria.

Bacteria are living organisms, invisible to the unaided eye but visible under a microscope of fairly high power. Individuals of most species fall in size between $\frac{1}{25000}$ and $\frac{3}{25000}$ of an inch. There is an assortment of shapes but all those so far known to attack plants are rod-like and most are capable of motion in fluid. Movement is usually effected by the lashing motion of delicate threads which are either distributed around the margin or are confined to one end.

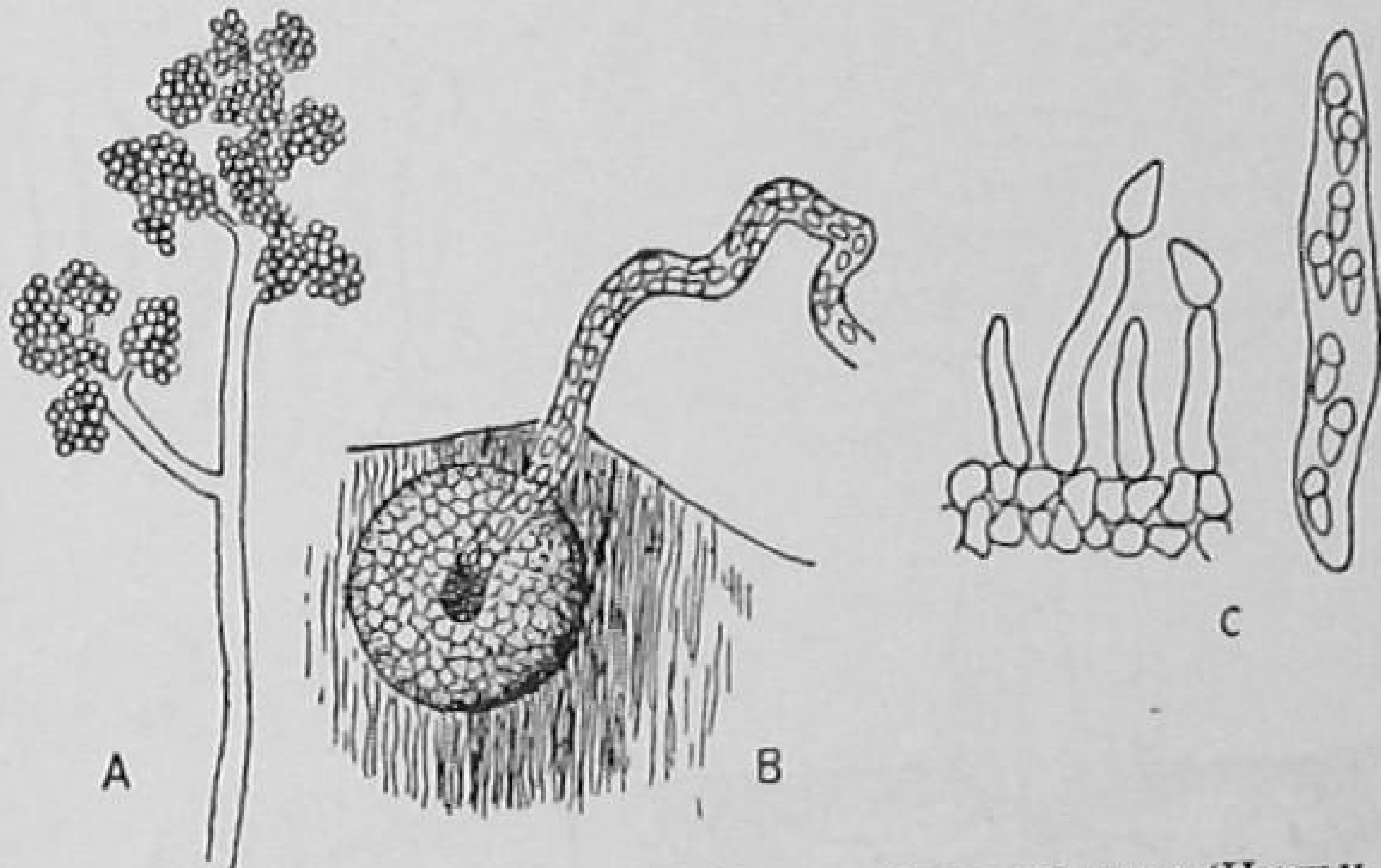

Fig. 2. A Random Selection of Fungal Fructifications (Highly Magnified) to Demonstrate Diversity of Type.

A. Heads of spores (conidia) of *Botrytis cinerea* on slender filaments (conidiophores).

B. Gelatinous tendril oozing from pycnidium of *Didymella lycopersici* (p. 814). Spores are embedded in the tendril.

C. *Venturia inaequalis* (p. 804). *Left:* Slipper-shaped spores (conidia) on short filaments. *Right:* A sac (ascus) from another type of fructification; the sac contains eight 2-celled spores (ascospores).

Method of Increase.

Their method of increase is simple: a fully grown bacterium will split into two; each member of this pair will again split to form a total of four, and so on. Under favourable conditions the time between the birth of an individual bacterium and its splitting is half an hour or less. A little elementary arithmetic will show that at this rate a single bacterium would increase to over a million individuals in ten hours and hundreds of billions in 24 hours. Fortunately, conditions do not remain permanently favourable for such prolific reproduction, for either the food supply gives out or death results from the effects of poisons produced by the bacteria themselves. Even so, multiplication can be alarmingly rapid before a check occurs.

As with fungi, bacteria are not all parasites, many living on the tissues of dead plants or on the products of decay.

Health and Disease.

We have talked of fungal and bacterial parasites attacking or infecting plants and so causing disease. The reader will have his own idea of what is meant by "health" and by "disease" and, on the whole, he will no doubt be right. But the position is not quite as straightforward as it may seem. If he had been a medical student he might have heard the lecturer define disease as "any condition of the organism which is a departure from health," and health as "that condition of the organism which is most prevalent in a very large number of individuals."

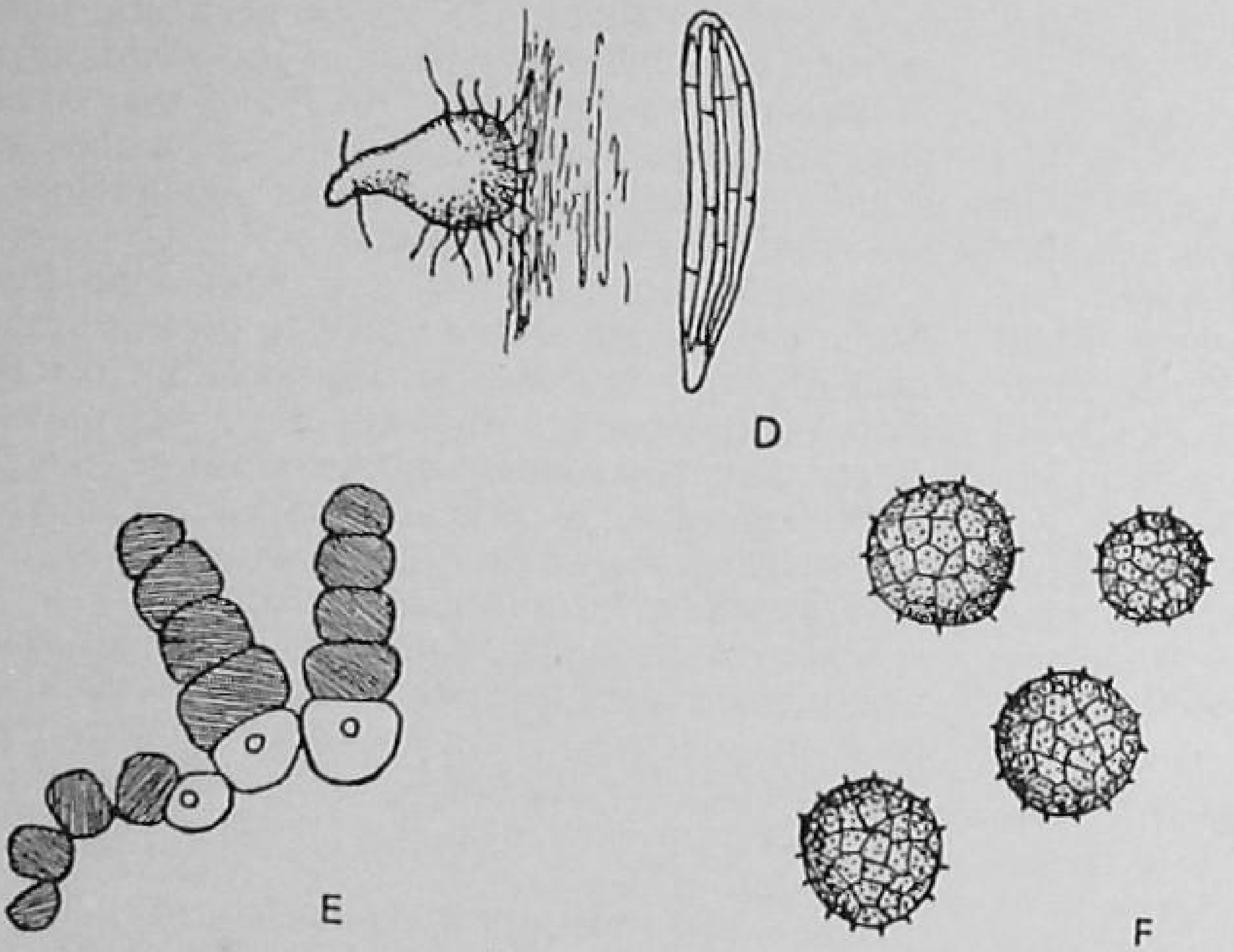

Fig. 2.—*continued.*
D. *Ophiobolus graminis* (p. 796). *Left:* Fruit body which contains numerous sacs (asci). *Right:* An ascus with eight long, septate spores.
E. Black spores (chlamydospores) of *Thielaviopsis basicola* (p. 814).
F. Spores of *Tilletia caries.*

These, like most definitions, are not perfect, because the variations among individuals of any species in the animal and plant kingdoms are enormous. Thus, we cannot label a four-leaved clover as diseased just because the vast majority are three-leaved. Neither does the presence of fungi or bacteria in living plants necessarily cause injury. There are, in fact, associations which work to mutual benefit and in which the relationship is not strictly that of parasite and host. Thus it is a common farming practice to dip the seeds of lucerne into a preparation of certain bacteria before sowing in order to supply the soil with microbes which will later live in the roots and assist with the nutrition of the plant. But in general, it is not difficult to decide that a plant is diseased if we find the leaves or the roots rotting before the season is at an end. As a rule, parasitic fungi and bacteria attack only part of a plant, but if that part is sufficiently important to the nutrition of the whole, then the plant will probably die. In this category are the root diseases; a dead plant soon follows from a dead root system. Most soils are teeming with bacteria and fungi, a few of them being parasitic. For instance, the soils of some districts contain the Club Root fungus which attacks the roots of plants belonging to the cabbage family; the roots first swell to many times their normal size, then rot, with the result that the above-ground parts collapse. Common also is wilting due to the presence of parasites in the water-conducting strands of the stems; the fungus threads, already in the soil, penetrate the roots and grow upwards, lodging and multiplying in these bundles of minutes tubes. Death of the plant may be due to blockage of the strands or to poisons produced by the fungus.

Disease, however slight, is to be seen in nearly every field and garden. It often takes the form of spotting of the leaves. Each spot is a pocket of dead tissue killed by the fungus or bacterium. If the spots are numerous or large, then the leaf will probably die and fall to the ground. The destruction of floral parts or seeds might be regarded as a form of limited injury to individual parts, but in reality it is much more than this for it means the death of potential members of the next generation. Pre-eminent among seed diseases is Bunt of Wheat: every farmer and every miller knows only too well the grains which, when broken, are found to contain black fungus spores and so belie their outwardly robust appearance (Fig. 7). Fortunately, modern methods of controlling the disease are so simple and effective that Bunt is not likely to appear in any quantity where good husbandry is practiced.

Fruit rots are a problem which concern not only the grower but also the shopkeeper and the consumer. Rotting plums with brown fungus pustules are part of the scene in most Kentish orchards at picking time. The careful fruiterer tries to regulate his supplies so that he stocks no more of these fruits than he can sell within a day or two because he knows that the disease is catching and will rapidly reduce his stock of plums to a rotting mass. Other fruits may be similarly infected.

Parasites and Saprophytes.

When it had first been proved that fungi and

bacteria were capable of causing disease in plants, there was a not unnatural tendency to consider these organisms to be responsible for all disorders and many of the early investigators were content to fix the blame on any fungus which appeared on a diseased plant. This proved to be an over-simplification: much more caution was needed for, as has already been explained, not all fungi and bacteria are parasites, many being saprophytes which live on decayed matter. From this it follows that tissues which have been killed by a parasite or by any other means may be invaded by saprophytes. There have been many instances in the past in which disease has been wrongly attributed to these saprophytes. Let the reader take warning that not every fungus growth seen on a plant is the *cause* of disease—it may be the *result* of disease (or of insect attack).

Selection of Hosts by Parasites.

A question commonly put to the Plant Pathologist (specialist in diseases of plants) is whether a parasite on one kind (species) of plant will attack another species. Will the Potato Blight fungus attack raspberries? In general, the more closely related the plants the more likelihood there is of the same parasite attacking both, but there is no golden rule. Some parasites will attack many unrelated plants; thus, the Silver Leaf fungus (*Stereum purpureum*) includes most orchard trees and many forest trees among its hosts. The Rust fungus on cultivated flax is an example of a more conservative parasite which seems incapable of passing to even the closely-related wild flax.

Virus Diseases.

In addition to fungi and bacteria, there is a third great group of disease-causing agents, the viruses. The discovery of the virus is very recent, but its importance disputes priority with the fungus; it appeals to the imagination because its nature is still shrouded in mystery and it does not conform with our existing idea of either living or non-living matter. The virus may, indeed, be the link between the two. Virus diseases of plants have probably existed since pre-historic times, but perhaps because the virus itself could not be seen with the most powerful microscopes and because the symptoms of disease were usually less clear-cut than those caused by fungi and bacteria, they escaped investigation longer.

History of Virus Disease.

Quite definite portrayals of a plant virus disease are to be found in a number of early 17th Century Dutch paintings of tulips. Some of these blooms have petals with variegated coloured stripes. Such "broken" tulips were popularized as new varieties by the growers in whose nurseries they accidentally appeared and who little suspected that the breaking up of one colour into several was due to disease. Other instances of alteration in flower colour by virus infection are now known, but economically we are more concerned with the effects leading to reduction of crop yields. Many virus diseases cause stunting of the whole plant accompanied by foliage changes such as yellowing, mottling or curling of the leaves. Death sometimes follows the first symptoms; at other times the plant may linger on in an unhealthy condition for months, or in the case of perennials, for years.

Since the virus was invisible even under the highest powers of the microscope, its discovery depended upon its infectious nature. In 1892, D. Iwanowski, a Russian, extracted the juice of a tobacco plant, the leaves of which were mottled in a manner typical of the well-known Tobacco Mosaic disease. He found that when this juice was introduced into the tissues of healthy tobacco plants their leaves also developed the same mottled appearance.

In order to rule out any possibility that bacteria or fungus spores might be present in the juice before inoculating the healthy plants, Iwanowski passed it through the pores of unglazed porcelain so that any bacteria large enough to be seen under a microscope would be filtered off. Hence the name "filter-passing virus," a term which is still sometimes used.

Since Iwanowski's discovery, many hitherto unexplained plant diseases have been proved due to virus infection. In a text-book published in 1939 the number of plant virus diseases described was 129 and new ones are being continually discovered.

The reader must not imagine that, in order to find out whether a diseased plant is infected with a virus, all that is necessary is to filter some of its juice and rub it into a healthy plant of the same species. In but few instances is it possible to transmit the disease so easily, and it was fortunate for Iwanowski's experiment that Tobacco Mosaic virus is particularly infective in this way. A very large proportion of viruses are much more "temperamental" and will infect a plant only if injected by certain insects. Even with insects, it may happen that only one species can spread the disease.

The demonstration of the infectiveness of the filtered juice of the diseased tobacco plant led to great discussion as to the nature of the infective principle. Some suggested that viruses might be bacteria which were too small to be seen under the most powerful microscope; others that the virus was produced by the diseased plant tissue itself.

Virus Crystals.

In 1935, W. M. Stanley, working with the same good-natured tobacco virus as did

Iwanowski some 40 years before, isolated a highly purified and concentrated solid preparation, crystalline in character, which was very much more infective than the juice from which it was extracted. During the few years since then, similar preparation (Fig. 3) have been extracted from other diseased plants and there is good reason to suppose that these substances are a form of the viruses themselves. There is thus the temptation to regard at least some viruses as pure "chemical" substances which have the ability to cause disease and multiply in the plant, but until more is known about the action of these "chemical" substances within the tissues, we would do well to keep open minds.

Virus diseases differ from those caused by bacteria and fungi in many respects. Two important points of difference are that the virus is usually present in every part of an infected plant except the seed and is present throughout the lifetime of that plant. It follows therefore that if any part of an infected plant, *other than the seed*, is selected for propagation, the new

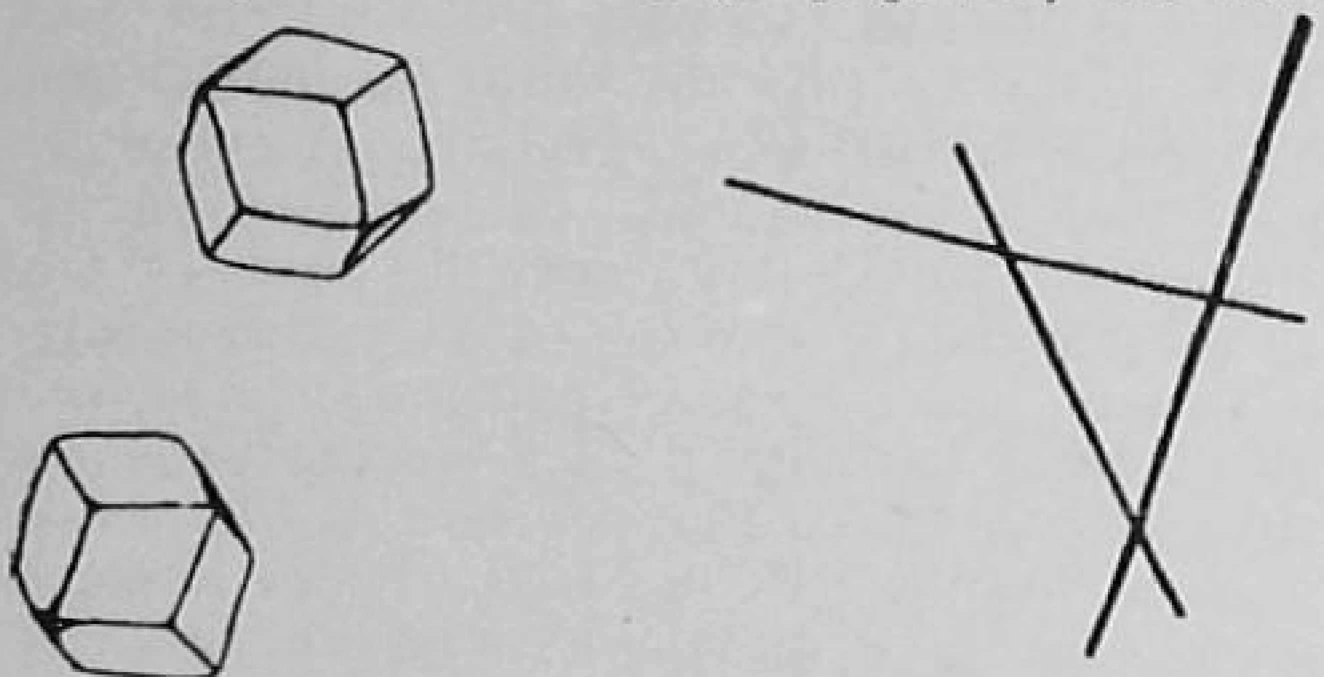

FIG. 3. VIRUS CRYSTALS.
When purified, some plant viruses have been shown to have crystalline form.

individual developed from the infected one will itself be infected. This, of course, has an important bearing on the spread of the virus. For instance, raspberries are propagated by selecting canes from existing plantations; strawberries from runners; hops from bines, and potatoes from tubers (miscalled "seed"). Virus diseases have played havoc with the productiveness of all these crops.

POTATO DEGENERATION.

The problem of degeneration of potato stocks is a good example of the hidden way in which viruses can work. For at least 150 years farmers in some parts of the country had been complaining that the yield of the crop was becoming progressively less each year that they planted from home-saved "seed". Soil could not be blamed for the serious reductions in yield, because when fresh stocks from certain other parts of the country were planted in the same fields an improvement followed. The most popular explanation was that stocks of the varieties in use were growing old and the decline in yield was due to old age. To appreciate the full meaning of this, it should be understood that every tuber of a single variety of potato is, in a sense, part of the original plant which was grown from a true seed—that is, from a pip taken from one of the tomato-like fruits which sometimes develop on potato plants. The well-known variety *Kerr's Pink*, for example, was raised in 1907, when it was represented by a single plant raised from a true seed. Each tuber from this individual was dug, stored and replanted, giving rise to many more plants; by repeating the process there were enough tubers within a few years to distribute to farmers. Tubers from the original plant, unless disturbed, would have rested dormant beneath the soil throughout the winter to sprout again in the same spot the following spring. By digging up the tubers and spacing them in the field, the separated parts of the old plant were given more space and a new source of nourishment, and so were infinitely more prolific than if left crowded together in the original spot year after year. If the tubers from this plant had been left in one spot it is probable that all the nourishment from the surrounding soil would have been used up in a year or two and starvation, together with overcrowding, would have resulted in death. Interference by the breeder and the farmer was therefore greatly extending its natural life, and it seemed feasible that there was a limit to its age even under kindly treatment. But there was a strong augument against this. Potato stocks of old established varieties could be grown year after year in parts of Scotland and Ireland without showing signs of degeneration.

Not until 1916 was the explanation to the problem discovered. In that year, H. M. Quanjer, in Holland, demonstrated the first of several virus diseases which are now known to be carried in tubers. Four years later a fellow countryman, Oortwijn Botjes, showed that the virus could be spread by certain greenflies (aphides).

Thus, from what has already been said, it will be evident that every tuber from a virus-infected potato plant is itself infected and will never give rise to healthy stocks, and that if an infected plant grows near healthy ones, then greenflies may carry disease from the former to the latter. The reason why potatoes in certain areas remain free from these diseases is that climatic conditions are unsuitable for movement of greenflies.

Examples of a few of the more common plant diseases to be met in Britain are given in the pages which immediately follow. It is hoped that these will give the reader, not only a few facts relating to the diseases themselves, but by acting as illustrations will prepare him for the later consideration of disease control.

NAMES OF PLANT DISEASES AND OF THEIR AGENTS.

There has been great confusion in the past on the naming of plant diseases, for plant pathology,

as an organized science, is very recent and the common name for a particular disease in one district was often quite different from the name given to the same disease in another district. Thus, the disease caused by the fungus *Plasmodiophora brassicae* has been popularly known as "Club Root," "Finger-and-Toe" or "Anbury." The word "Blight" has long been in favour with the farmer to describe any disease which involved rotting of plant tissues. To overcome this confusion the Plant Pathology Committee of the British Mycological Society have compiled *A List of Common British Plant Diseases* in which a single name is recommended for each disease in the list. The names in the present section of this work comply with those in the list.

It is not often that the agent (fungus, bacterium or virus) causing a disease has been given a common name but, as with all living things, every known fungus and bacterium has been labelled with a scientific name consisting of two words denoting the *genus* and the *species* respectively; thus, *Phytophthora infestans* is the name of the fungus which causes "Blight," the potato disease, and the name *Phytophthora infestans* will apply to that fungus alone and to no other living organism. *Phytophthora cryptogea* is a fungus which attacks the roots of tomato plants and it has sufficient salient points in common with *P. infestans* to be included in the same genus *Phytophthora* but other minor differences justify another specific name, that is, *cryptogea*. The fungi, *Fusarium caeruleum*, which causes another potato disease, and *Ophiobolus graminis*, which causes a disease of wheat, have little in common with *P. infestans* or with each other and their first (or generic) names are therefore quite different.

The discovery of viruses is so recent that no stable names, either popular or scientific, have generally been adopted and all names used must be regarded as tentative. Thus, "Mosaic" of tobacco is produced by the tobacco mosaic virus and various strains of this virus also produce "Mosaic," "Yellow Mosaic," "Enation Mosaic" and "Streak" of tomato. Again, "Leaf Drop Streak" disease of potato is the result of recent infection by potato virus Y; but tubers containing this virus produce plants with quite different symptoms which are best known as "Rugose Mosaic."

DISEASES OF POTATOES

HISTORY has been greatly influenced by potatoes. It is probably true to say that long wars would be impossible without them and readers who have lived through two world upheavals must be aware of our reliance upon the crop. Since we cannot turn the clock back by banishing potatoes, it is well for us to realize that the nation which looks after them well has a better chance of withstanding the enemy than one that does not.

There are at least fifty recorded disorders of the potato of which more than thirty are mentioned in the list of Common British Plant

FIG. 4. WART DISEASE OF POTATO.

The warty or cauliflower-like outgrowth has become black in colour. It contains a large number of long-lived spores of the fungus (*Synchytrium endobioticum*) responsible for the disease. Large numbers of the spores will have been left in the soil where they will remain infective for many years.

Diseases and at least half of these affect the tubers only. Common Scab (*Actinomyces* sp.) is the best known of the several external blemishes: others include Skin Spot (*Oospora pustulans*), Black Scurf (*Corticium solani*) and Powdery Scab (*Spongospora subterranea*). Under certain conditions these may damage the eyes and so reduce the value of the tubers for seed. Wart Disease (*Synchytrium endobiticum*) (Fig. 4), which was once as well known as it was devastating, has literally been exorcised by a joint effort of the plant breeder and an Order under the Destructive Insects and Pests Acts. Alternaria Blight (*Alternaria solani*), well known in the American continent as "Early Blight," has been recorded in Britain for the last two or three years, but so far it has not caused much damage.

Outline accounts follow of five of the more important diseases of potatoes, three of them caused by fungi and two by viruses.

POTATO BLIGHT.

Something has already been said of Potato Blight (*Phytophthora infestans*) and how it caused the great Irish Famine. It is still perhaps the most important of all potato diseases and occurs nearly everywhere that potatoes are grown. But because warm moist conditions are necessary for its spread, the amount of damage done is not the same in all districts and in any particular area varies from season to season. In the British Isles, it is most ravaging in Ireland, in Wales and in the West of England.

In the Home Counties the first signs of infection are not often seen before June and sometimes not until late summer. Brown spots appear on the leaves and, if humid conditions prevail, the size of the spots increases, until whole leaves are killed. Finally, the foliage of the crop becomes a black rotting viscid mass with a characteristic unpleasant smell. On the other hand, if a period of dry weather follows the first infection, the patches of dead tissue will shrivel and the progress of the disease will be checked.

Discoloration and death of the leaves is due to the presence of the mycelium of the fungus within them. The mycelium creeps between the individual cells, and sends out small peg-like processes which penetrate the cell wall and "feed" on the contents. If the underside of an infected leaf is examined during humid weather, a white cottony growth may be seen around the margin of each brown spot or patch (Fig. 5). This growth consists of spore-bearing branches of the fungus which have arisen from the mycelium inside the leaf and have grown out to the air through its breathing pores. The spores, which are lemon-shaped, are too small to be seen without the aid of a microscope. If one of the spores falls onto a potato leaf, it may cause a new infection by germinating directly and producing an infection-thread; this will penetrate healthy tissue. Alternatively the spore may extrude a number of smaller spores (zoospores), each of which can cause a separate infection. The zoospores are equipped with lash-like processes and by means of these they can swim through films of water on leaves. The method by which infection will occur depends whether there is moisture present and upon other conditions, but the spread of the disease owing to production of zoospores is considered to be the more common. Spores are washed by rain from upper to lower leaves and are also carried by the wind or by rain-splashes from one plant to

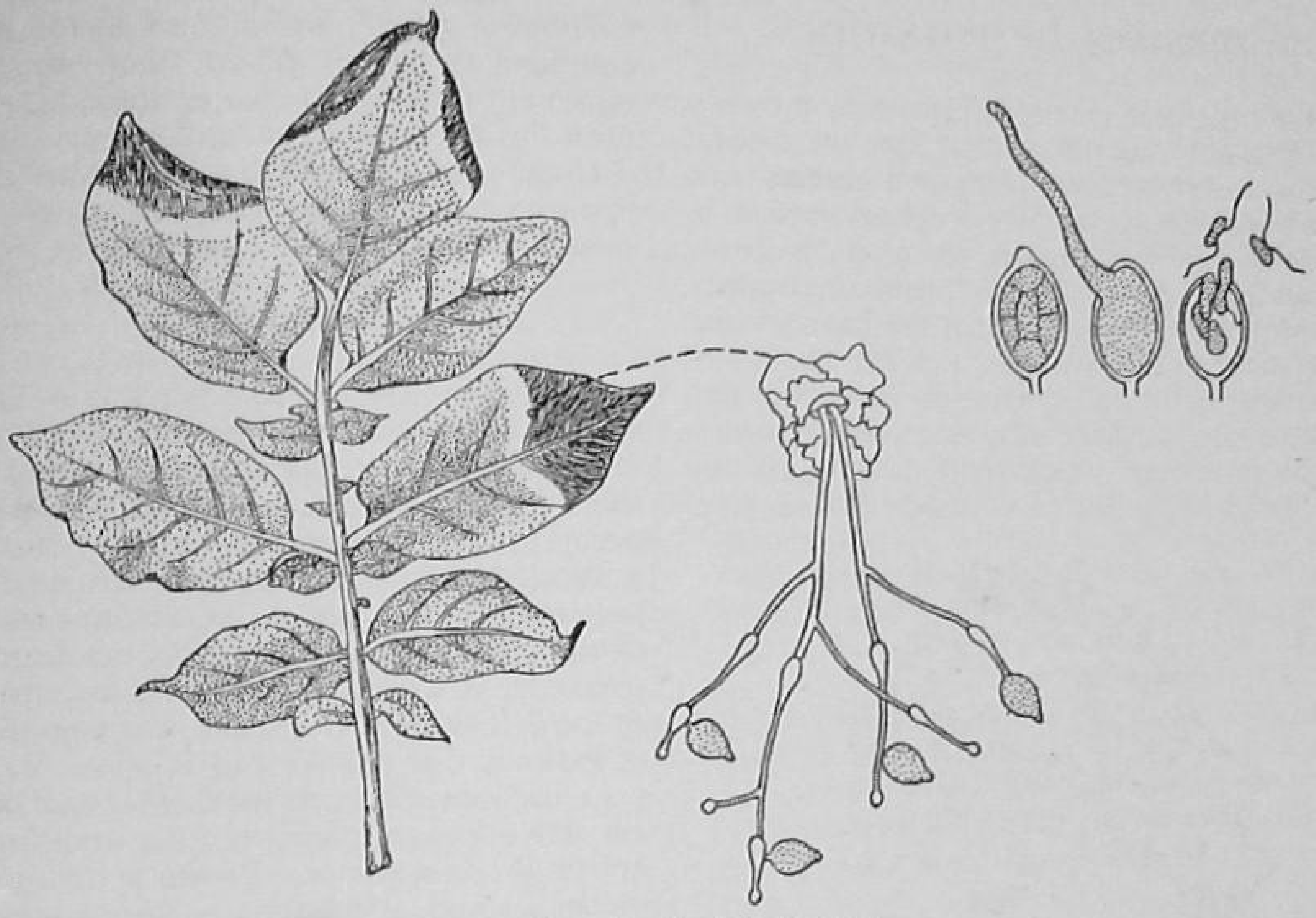

FIG. 5. POTATO BLIGHT.

Left: Underside of potato leaf showing infected leaflets. A band of white sporulating fungus separates the shrivelled from the healthy tissue.

Centre: Spore-bearing filaments highly magnified; they arise from breathing pores on the underside of the leaf.

Right: Spores; one is germinating directly by means of a germ-tube and another by means of swimming zoospores.

another. Given favourable conditions, spread can be so rapid that a healthy field of potatoes may be converted into a mass of rotting foliage within a week or two of the first infections.

Death of the foliage is, of course, followed by cessation of tuber development and there is a corresponding reduction of crop yield. If the attack upon the foliage is slight, or happens near the end of the growing season, the reduction of yield will be negligible. Decrease in weight of yield is serious enough, but this is not all that can happen. There is a great risk that the tubers themselves may become infected and rotten. This is brought about by spores being washed from the foliage to the tubers and not, as might be expected, by the mycelium of the fungus passing downwards through the stem.

Tubers may show signs of Blight at the time of lifting, but if infection is recent, recognition is not always possible until after a few weeks of storage. Brown or purplish areas then show on the surface and, when the potato is cut, the flesh beneath is seen to be rusty red. The discoloration may be shallow or deep; it often involves the whole of the tuber. Diseased tissue remains firm unless, as frequently happens, other organisms, bacteria, or fungi, enter when the tuber becomes soft and mushy.

A great deal of investigational work has been carried out in the present century to discover how the disease begins each year, for it is known that the spores which spread the disease from the foliage of one plant to that of another cannot live for more than six weeks at most and their life is usually much shorter. Three or four theories have been advanced, but without discussing these it can be said that the most acceptable at the present time lays the blame on tubers which were infected the year before. A proportion of such tubers is still capable of sprouting and the fungus grows from the diseased flesh into the young shoot. Small undersized leaves are produced and these can bear spores in the manner described above. On farms and in gardens some tubers are sure to be accidentally left in the soil undug (ground-keepers) and these, together with others which are thrown out during sorting would provide a source of abundant spores.

Death of potato foliage and the rotting of tubers is not always the result of attack by *Phytophthora infestans*. There are several other possible causes but the name "Potato Blight" strictly applies only to the disease associated with this fungus.

Control measures are directed against prevention rather than cure because the fungus lives within the tissue of the foliage and of the tubers and any known treatment which would kill the parasite would also kill the host. From what has already been said it seems likely that if there

were no infected tubers to sprout in spring or summer, then there would be no source of infection. It is therefore a sound practice to leave as few tubers as possible in the ground at lifting time and to make sure that there are no blighted tubers among the " seed " at planting time. Also, when constructing or sorting out a clamp, discarded potatoes should be fed to stock or buried in a deep hole and not thrown on the dung heap or left about the farm. By observing these precautions, attack by Blight may be delayed if not prevented. In districts where Blight is liable to appear early, the probability is that spores of the fungus will in any case find their way to all parts sooner or later if weather conditions are favourable. In such districts particularly, it is essential to cover the foliage with some protective substance and this should be done before the first attacks are expected.

Most protective substances contain copper in one form or another. They are prepared as fluids for spraying or as powders for dusting. Certain of the fluid types are to be preferred because once the preparation has dried on the leaves it will not wash off readily but will leave a deposit from which traces of copper will be brought into solution whenever the leaves become moist. The swimming spores of *Phytophthora infestans* are very easily killed in the weakest of copper solutions. Powders and some fluids, though perhaps good fungicides, do not stick well to the leaf surface and are too easily washed off when rain comes; and this is, of course, the very time when the fungus is liable to spread.

A fungicide which has stood the test of time is home-made Bordeaux mixture, the preparation of which is described later in this section. In recent years, many new copper-containing fungicides have been made and are recommended by the makers for Blight control. They usually have the advantages that they are both easier to mix and easier to pass through a spraying machine. The date at which the first spray should be applied depends upon the earliness or lateness of Blight in the particular district. In the south-eastern counties, for instance, the first week of July is considered soon enough, but this would be too late for the warmer and wetter south-west. If Bordeaux mixture or a fungicide with equal sticking powers is used, it is probable that the deposit on any full-sized leaf will continue to protect it until harvest time, but as new growth develops, this must not be left too long without protection. For this reason more than one application is necessary. A total of three sprayings with an interval of two or three weeks between each is usually sufficient.

In the midlands and the north, Blight is late and the tubers are usually well developed by the time the foliage is attacked. This fact has cast doubts upon the need for leaf protection in these areas and spraying with a copper compound is less frequently undertaken, but the risk of tuber infection by spores falling from the leaves still remains. Earthing up in the rows, if properly carried out, will provide some protection. This cultural operation should result in laying a *flat* pad of soil over the tubers; as it is often done in gardens and allotment, the ridges are " knife-edged " and the tubers are thus exposed to infection through the sloping surfaces.

Tuber infection is especially likely to occur at digging time, particularly if conditions are moist. For this reason it is best to select a dry day. It is also a sound plan to cut off or burn off the foliage at least a fortnight before digging. Cutting with a scythe or bagging-hook is practicable with small areas but with large fields the tops are most easily burnt off by spraying with 10 per cent-15 per cent sulphuric acid. Special acid-resisting tackle is needed for this and many farmers find it convenient to invoke the aid of a contractor. Sulphuric acid treatment not only aids control of Blight in the tubers, but it also facilitates harvesting by shrivelling haulm and weeds. The practice has become a routine on many farms.

While no existing commercial varieties are immune to attack by Blight, varieties differ in their degree of susceptibility. Thus, of the two well-known varieties Majestic and King Edward, the former shows a marked degree of resistance while the latter suffers more severely from the disease when exposed to the same degree of infection. The popularity of Majestic among farmers in certain areas of England is partly due to this resistance.

Dry Rot of Potato.

Potato Blight has been shown to rot both the foliage and the tubers. Another disease, Dry Rot, affects the tubers only, but like Blight it is caused by a fungus. Most Dry Rot is attributed to *F. Fusarium caeruleum* but another species, *F. avenaceum*, has recently been proved to cause like symptoms. The habit of these fungi is different from that of *P. infestans* in that they are normal inhabitants of some soils in which they live as saprophytes. When the opportunity presents itself the saprophyte becomes a parasite and enters the flesh of the tuber causing a rot of a special type which has recognizable features (Fig. 5). Shrinkage of infected tissue takes place and a characteristic wrinkling of the skin occurs. At the same time white or pinkish cushions of the fungus breaks out on the surface and sickle-shaped spores are produced on these. The rotted tissue is dry and contains cavities which are sometimes filled with a white or blue mycelium. Certain varieties are particularly susceptible to the disease; these include May Queen, Ninetyfold, Arran Pilot and Doon Star. Majestic is also severely attacked at times.

It has been shown that mass infection takes place only after wounds have been inflicted on the tubers. Such injury may occur at lifting time

or later. Meanwhile the fungus is present in the particles of soil adhering to the surface of the tuber and merely awaits an opportunity to gain entry through broken skin.

It is not widely enough appreciated that potato tubers are living entities and as such should be treated with respect. Too often they are roughly handled at the time of digging and the mechanical "spinner" often ruptures the skin. After this they are collected in boxes, poured into sacks and bundled about in their close community until they have bruised one another. Damage is also frequent at the different stages of their transport and Dry Rot causes especially great losses in those areas which import tubers for use as "seed." For example, let it be assumed that "seed" potatoes grown in Scotland are sent to Kent. At the place of origin they are put into sacks and loaded into trucks for sending south. On delivery to the farmer or gardener they all appear sound on casual inspection but close examination with a magnifying glass would have revealed places where the skin has been broken. The fungus, *Fusarium caeruleum*, was present in the soil in which the tubers were grown and was alive in particles of that soil still adhering to their surface. Infection took place through the wounds and rotting progressed in the following weeks. When again examined the farmer finds that nearly half his "seed" is useless for planting because of Dry Rot, although he has accepted it as being in good condition on delivery. Neither the "seed" producer nor the merchant are to blame.

The soil in which the potatoes are grown is not always the source of the disease however, since the fungus may have been present in particles of soil harboured in sacks used for transit or for storage or even in the wooden boxes used by the farmer for sprouting the tubers prior to planting. But here again, infection can only occur if the tubers have received recent damage.

The reader will immediately see that the obvious way to reduce loss from Dry Rot is to avoid damaging the tubers. This is easy enough under garden conditions when lifting is done with a fork and when seed-sized tubers may be picked up by hand and carefully rested in boxes to sprout. But under commercial conditions some injury is almost inevitable. Recent research work has shown that infection may be greatly reduced if the tubers are dipped at the right time in formalin or in certain mercury compounds. Still more recently the application of disinfectants in the form of dusts has proved successful. The best time to dip the tubers is related to the time at which bruising is likely to occur and in certain circumstances it may be advisable to give more than one treatment. Further investigation is needed before a rigid programme can be recommended.

If Dry Rot has appeared, it is a wise precaution to disinfect "seed" boxes with 5 per cent formalin before using them again in the following year.

Common Scab.

Common scab is perhaps the most widespread and most familiar disease of potato tubers. It is the usual cause of the pitting and roughening of the skin which makes the housewife peel thickly. But because the tubers are only superficially damaged and do not rot, less attention has been given to this disease than it deserves. An accurate estimate of the yearly loss which results from thick peeling has not been attempted, but it must be very great.

Common Scab is caused by species of the genus or group of organisms known as *Actinomyces.*

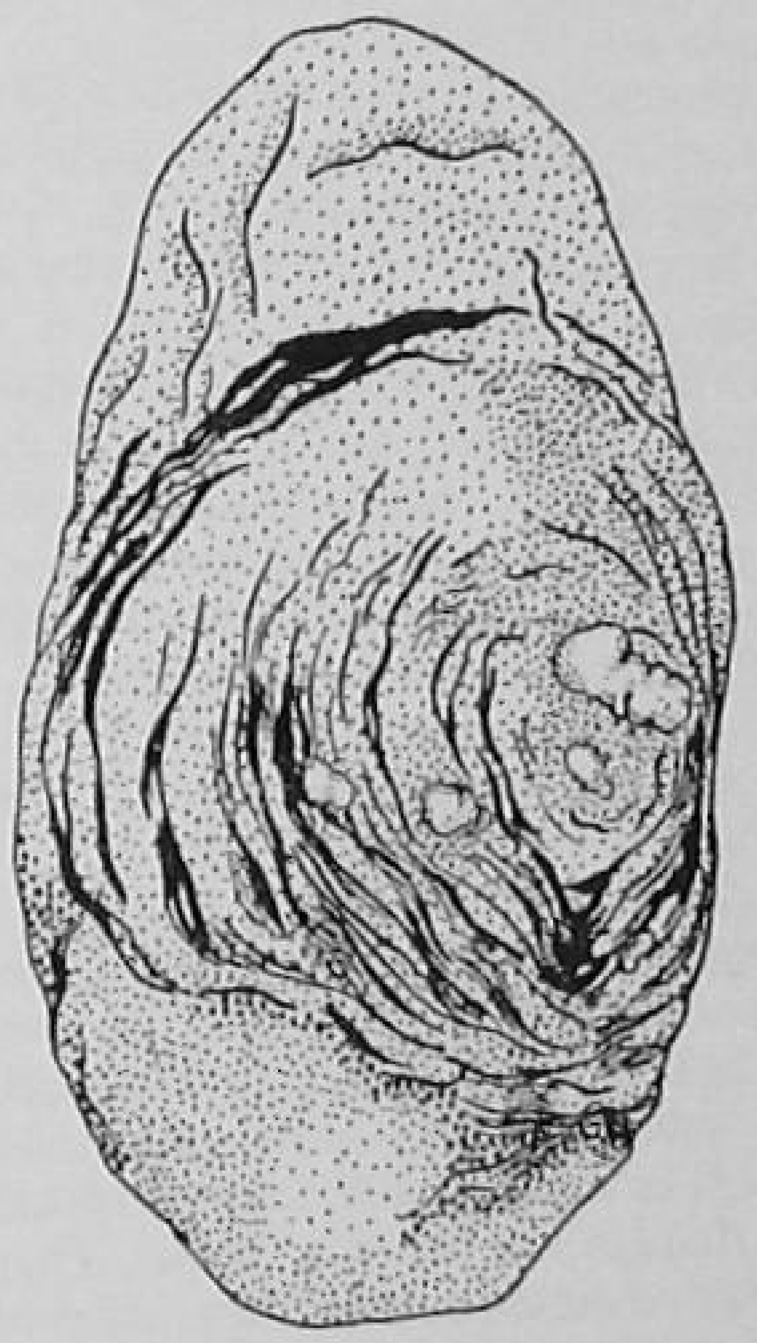

FIG. 6. DRY ROT OF POTATO.

The infected part of the tuber shrivels and tends to produce concentric wrinkles. White or pinkish pustules often appear on the surface.

This genus has some of the attributes of a fungus and some of a bacterium. It is present in soil as a very thin mycelium, some of the branches of which are capable of breaking up into small cells resembling bacteria. Under favourable conditions, the mycelium penetrates the breathing pores of potato tubers causing the death and collapse of surface cells and giving rise to the well-known "scabs." These blemishes may take the form of shallow or deep pits or they may be raised above the surface. Infection can occur at any time from that of early tuber formation until maturity but, of course, there is no evidence to be seen until digging time because the foliage is unaffected.

The disease is worst in dry seasons and is favoured by sandy and gravelly soils rather than

those of heavier texture. The organism may be introduced into the land with scabby "seed." Risk of infection from this source can be greatly reduced by dipping the tubers before planting in a solution of 1 part of mercuric chloride (corrosive sublimate) to 1,000 parts of water for 2 hours. This measure is, of course, useless if the soil is already contaminated. The corrosive sublimate has to be handled with great care as it is an extremely dangerous poison.

On soils devoid of organic matter, liming is likely to increase the amount of Scab while the incorporation of organic matter in the form of green manure decreases it. The ploughing-in of a green crop such as mustard shortly before planting has proved beneficial; the inclusion of grass mowings in the trench at planting time has a similar effect, but this is practicable only on a garden scale.

There is a great difference in the susceptibility of different varieties. In one test made on more than thirty varieties Doon Early, Ally, Eclipse, Epicure, Majestic and May Queen were the most badly affected. It does not necessarily follow that the order of susceptibility of varieties is the same with all strains of the fungus. If a soil is known to produce severe Scab the grower would do well to experiment with a few varieties so that he may decide for himself which are the most suitable for growing on his land.

Potato Virus Diseases.

The degeneration of potato stocks has already been shown (p. 788) to be the result of virus diseases. A number of such diseases is now recognized. The virus causing each is usually known by a letter such as virus A or virus X and each disease is given a name descriptive of the most prominent symptoms seen on the plant. Leaf Roll (which has no letter) and Rugose Mosaic (virus Y) are the most important of the diseases which cause degeneration; another Mosaic (virus X) is widespread throughout the stocks of certain varieties but it causes much less damage than Rugose Mosaic or Leaf Roll.

Leaf Roll.

In passing through a block of allotments during the summer in the southern or eastern counties of England, some plots of potatoes will usually be seen in which the leaves of many plants are erect and rolled upwards and inwards showing an under surface which is yellowish, silvery or tinged with red. On account of the stiffness of the foliage such plants have been aptly described as having a "scared" appearance. The leaves, instead of being soft and flexible have a leathery texture and rattle when the plant is shaken. These are the symptoms of virus Leaf Roll and it is quite likely that the "seed" tubers from which the plant grew were not bought as certified seed but were saved by the allotment holder himself from the crop of the previous year. The plants will not recover but will remain stunted and will give a poor yield; the tubers will be small and all will contain the virus.

The virus itself cannot be transmitted by simply introducing infected sap from a diseased plant into the tissue of a healthy one. In nature, transmission is brought about by the agency of certain species of greenfly (Aphide), particularly the Peach Aphis, *Myzus persicae*.

The Aphis Vector.

The aphide is an insect with mouth parts especially suitable for penetrating tissue and sucking up fluid. Saliva is passed into punctured tissue through one channel and is then sucked up through another. If the aphis feeds on a diseased plant the saliva may take up the virus. The same aphis feeding later on a healthy plant will probably infect it. The history of the virus while it is inside the aphis is still not fully understood. It is however known that transmission depends on several conditions. For instance, *M. persicae* is not infective until about 24 hours after feeding on a diseased plant and during this interval the virus must travel from the insect's intestine to its salivary glands. Whether at the same time changes occur in the nature of the virus itself is still a subject for speculation.

Not all aphides found on potatoes are carriers of the virus although their feeding mechanism is similar. Differences in habits and in depths of penetration by the mouth parts are probable explanations. It is well known that *M. persicae* is not inclined to fly if the temperature is below 65°F. or with the relative humidity over 70 per cent, nor if there is a wind of more than eight miles an hour. *M. persicae* normally lays its eggs in the crevices in the bark of peach trees and can pass mild winters as adult insects on plants of the cabbage family. In those parts of Scotland where "seed" potatoes are produced there are few peach trees, winters are too cold for the survival of the adults and conditions are generally unfavourable for the movement of this species of aphis. In consequence Leaf Roll is rare and a farmer may grow crops of potatoes each year from his own-saved seed without fear of mass infection and may sell the surplus as healthy "seed" to those districts in which the disease is a menace.

Primary and Secondary Infection.

When an infected tuber is planted it produces normal foliage. If this has been visited by *M. persicae* or other aphis carrying the Leaf Roll virus, the first symptom to be seen is the rolling of the top leaves. Stunted growth and a reduced yield of tubers may follow, but, in any case, every tuber produced by that plant will contain the virus. Each of these tubers, if used for seed the following year, will give rise to sickly plants

showing the symptoms described at the beginning of this section, but the first leaves to roll will be the lower ones. This difference, whether the upper or the lower leaves are the first to roll, makes it possible to say whether the seed tubers were infected at the time of planting or whether infection occurred after the haulm appeared above ground.

Virus infection is not the only cause of the rolling of potato leaves. Certain fungi or bacteria attacking a plant at or below ground level can cause a similar rolling. Also, a few varieties such as Sharpe's Express and Gladstone have the natural habit of rolling the leaves, particularly in dry seasons.

Rugose Mosaic.

There are several viruses which, singly or in combination, can cause a mottling of potato leaves. The most important of these is virus Y which is widespread in Britain and is responsible for greatly reduced yields. Not all potato varieties show identical symptoms; in Majestic and Arran Banner for example, a condition known as Leaf Drop Streak follows first year infection. Shortly after a healthy plant of one of these varieties has become infected, dead, black spots appear on the lower leaves and this is accompanied by a general mottling of the foliage. Black streaks then appear on the underside of the veins of the lower leaves; and these leaves eventually die and fall off or hang suspended from the stem by a thin thread of tissue. The youngest leaves at the top of the plant, although mottled and puckered, do not fall and the appearance of a plant at this stage has appropriately been compared to a palm tree. Tubers from plants which have shown Leaf Drop Streak, if used as seed, produce plants which are stunted and have mottled and puckered foliage, but do not show the other symptoms of the first-year infection. As with Leaf Roll, this disease is carried from plant to plant by aphides, particularly *M. persicae*.

The importance of virus diseases of potatoes in England can hardly be over-emphasized. Each year more farmers are recognizing the value of obtaining seed from districts where healthy stocks are raised. To aid them in this practice, in 1931 the Department of Agriculture in Scotland launched a scheme for the inspection of growing crops. Under this, certificates are issued if varieties are found to be pure and there is relative freedom from the main virus diseases.

Recently, British farmers have purchased from Scotland about 500,000 tons of potato seed each year. This is nearly enough to plant half the total acreage of potatoes in England. Similar certification schemes have also been adopted in Ireland and N. Wales.

Every potato grower, whether on a farm or garden scale, would do well to ascertain whether virus diseases are severe in his district and, if so, to obtain expert advice as to whether it is advisable or not to use certified seed each year or perhaps only at intervals of two or three years.

DISEASES OF CEREALS

Mildew.

Under the heading of "Diseases of Cereals", "Take All" and "Whiteheads" of wheat and barley, some of the cereal "rusts" and the "smuts" are described in some detail. These are the most important diseases; among the rest Mildew (*Erysiphe graminis*) is perhaps the most likely to attract attention. It may be seen on wheat, oats, barley and rye and on many other grasses. In some seasons the fungus appears as a grey matted growth on the lower leaf-sheaths of autumn-sown wheat, but it is not likely to become general until after May. In late summer the fungal mat becomes brown and fruiting bodies (*perithecia*) appear in the form of minute black specks within the tangle of mycelium. Mildew has received little attention from research workers, probably because the attack is rarely disastrous. Nevertheless, interference with leaf function must influence growth adversely, and in those years when the disease is rife the cumulative loss of yield may be high.

"Sooty Ears."

Sometimes after a wet season, the ears of mature wheat may be covered with Black Mould. The mould itself is a harmless saprophyte but its presence means that the chaff is dead and this may point to premature "ripening" of the plant following infection of the roots or stem by one of the soil-borne fungi.

Eyespot Lodging.

Until about 1935, the "lodging" of wheat and barley was nearly always attributed to the action of high winds. Naturally, these do sometimes cause the trouble, but it is now known that when the bend in the stalk is near ground level it is often due to infection at that point by the Eyespot fungus (*Cercosporella herpotrichoides*). This fungus like other soil fungi becomes most virulent if rotations are too short.

Helminthosporium Diseases.

Leaf Spot and Seedling Blight of oats (*Helminthosporium avenae*) Leaf Stripe (*H. gramineum*) and Net Blotch (*H. teres*) of barley are bogies, which, like Bunt of wheat, have been fading into the background since the advent of organo-mercury seed disinfectants.

Take All and Whiteheads of Wheat and Barley.

Since cereal crops, particularly wheat, play such an important part in the feeding of Western Nations, a great deal of research work has been carried out on their diseases. With some of these, including Bunt, a happy conclusion has been reached and control presents little difficulty. With others, including Yellow Rust, the partial solution has been the breeding of resistant varieties. But perhaps the greatest body of recent work has been concentrated on soil-borne parastic fungi, especially those causing Take All (Whiteheads). Infection by these subterranean parasites is usually severe only when a succession of straw crops is grown on the same soil. The trouble can therefore be avoided by a judicious scheme of rotation. Such a scheme does not necessarily suit the economy of every farm and was not practicable everywhere during the war years.

"Take All" and "Whiteheads" are names which have been used loosely by farmers to describe phenomena rather than to indicate specific diseases. "Take All" refers to the loss of young plants of wheat and barley, while "Whiteheads" is descriptive of plants with prematurely yellowing ears which stand out among the green-headed corn some weeks before natural ripening is due. Such ears usually contain shrivelled grain. More often than not, these symptoms are the result of attack on roots and base of stem by the soil-inhabiting fungus *Ophiobolus graminis*, but infection by species of *Fusarium*, notably *F. culmorum* and *F. avenaceum* can cause like symptoms. To make a distinction between the two diseases, that caused by *Fusarium* sp. has been named Brown Foot Rot.

O. graminis is common in Australia, America and Europe. In England it is serious mainly on certain light-textured soils overlying limestone and heavy losses can occur on these in wet seasons.

Take All.

When young plants are attacked, the roots and stems become infected by the fungus, and this causes a yellowing and withering of the leaves. If infection is severe, large patches in the crop may die.

Whiteheads.

In nearly mature plants bleached ears or white heads are seen scattered here and there, singly, or in small groups; these are the most severely affected but the remainder of the crop is also likely to be attacked, more or less, with a corresponding reduction in the quality of the grain. If an affected plant is dug out of the ground and the base of the stalk examined, it will be seen to be black. If the leaf-sheath which envelops the lower part of the stem is peeled off a black mat will be revealed encasing the stem. This black mat is made up from the interwoven mycelium of *O. graminis*. At a certain stage of maturity of the fungus, fruiting bodies (perithecia) are just visible with a lens as minute mounds protruding above the general level of the fungal mat.

O. graminis has been proved present in a great many soils, particularly under grassland, but it does not necessarily cause obvious damage to

wheat or barley. The circumstances which encourage it to attack are not well understood. Certain soil conditions undoubtedly influence its activity. It is most virulent in alkaline soils and is favoured by moisture.

The successive growing of wheat or barley increases the amount of fungus in the soil and seems to increase its ability to attack these hosts. The ploughing of stubble of an infected crop is, of course, an efficient means of returning mycelium and spores to the soil and so to aid further infections.

O. graminis is very commonly found on the roots of a number of different kinds of grasses but it does not seem to inflict much damage and is not regarded as a significant disease of grassland. On the other hand, some grasses help to carry over the fungus between the advents of susceptible cereal crops.

Oats are not attacked by the common form of the fungus but another form, *O. graminis* var. *avenae* has recently made its appearance in Wales and in certain parts of Scotland and of the North and North-west of England, but the damage it causes is small.

Brown Foot Rot.

The symptoms of disease produced by *Fusarium* are similar to those caused by *O. graminis*, but the colour at the base of an infected stem is brown rather than black, and under moist conditions the mycelium of the fungus may form a white or pinkish cottony growth with abundant spore masses on the surface. Further, *Fusarium*, though common in many soils, attacks roots and stems of cereals severely, mainly under poor soil conditions; when the soil is sour or badly drained, for instance.

In controlling *Ophiobolus*, adequate periods of rest from susceptible crops is the main part of the programme. The early ploughing in of stubble helps to rot some of the fungus on the dead roots. A firm seed bed slows down the movement of the fungus in the soil so that opportunity for consolidation after autumnal rains is advocated in vulnerable areas, even though this does mean late sowing. Well-balanced manures encourage a vigorous root system which is better able to repulse fungus attacks than is a poor one.

Fusarium presents a somehwat different problem and for control of this the emphasis is on improved soil conditions. Another feature is that the fungus may be carried with the grain (the pink mycelium may be seen on the ears in a wet season) and treatment of seed with an organo-mercury dust gives some benefit by disinfecting the exterior of the seed. Sometimes, seed is also internally infected and for this there is no remedy.

BUNT OF WHEAT.

To the less observant, the first sign that wheat is "bunted" does not appear until the grain has left the threshing machine. In the sack it looks as if it has been shaken with some very finely powdered soot. Close inspection of one of the "bunted" grains shows that the black "dust" is especially concentrated in the groove and among the bristles which are to be found at one end. Under the microscope each black particle is seen to be a spore of *Tilletia caries* (Fig. 2F.), the Bunt fungus. If grains from the same sample are crushed or cut in halves (Fig. 7), some of them will be found filled with similar spores instead of with the white starchy content of healthy millable grains. Actually, many of the spore-filled grains will have been broken during threshing. Of the millions of spores thus released, a proportion adheres to the surface of the accompanying healthy grains.

When such "bunted" grain is used for seed, the spores adhering to the surface germinate at about the same time that the young wheat shoot appears. The germ-tube from the spore penetrates the shoot and, once inside, forms a mycelium which grows upwards, approximately keeping pace with the growth of the stem. At the time of

FIG. 7. BUNT AND LOOSE SMUT OF WHEAT.
Left: Wheat ear infected by the Bunt fungus. The chaff stands outwards; the grain is filled with black spores. *Centre:* Ear and grain of healthy plant. *Right:* Wheat ear infected by Loose Smut; the spore-filled grains have burst in the ear leaving it shattered and blackened with adhering spores.

ear development the fungus extends into the forming grains where it produces myriads of spores. Until the ears have developed it is not possible to recognize infected plants by their outward appearance, though it has been stated by some observers that the shade of green in leaf and stem is different from that of uninfected plants. There is no doubt however that the glumes (chaff) of ripening ears which contain spore-filled grains tend to stand outwards towards the horizontal and the grains themselves are shorter and fatter than healthy grains (Fig. 7).

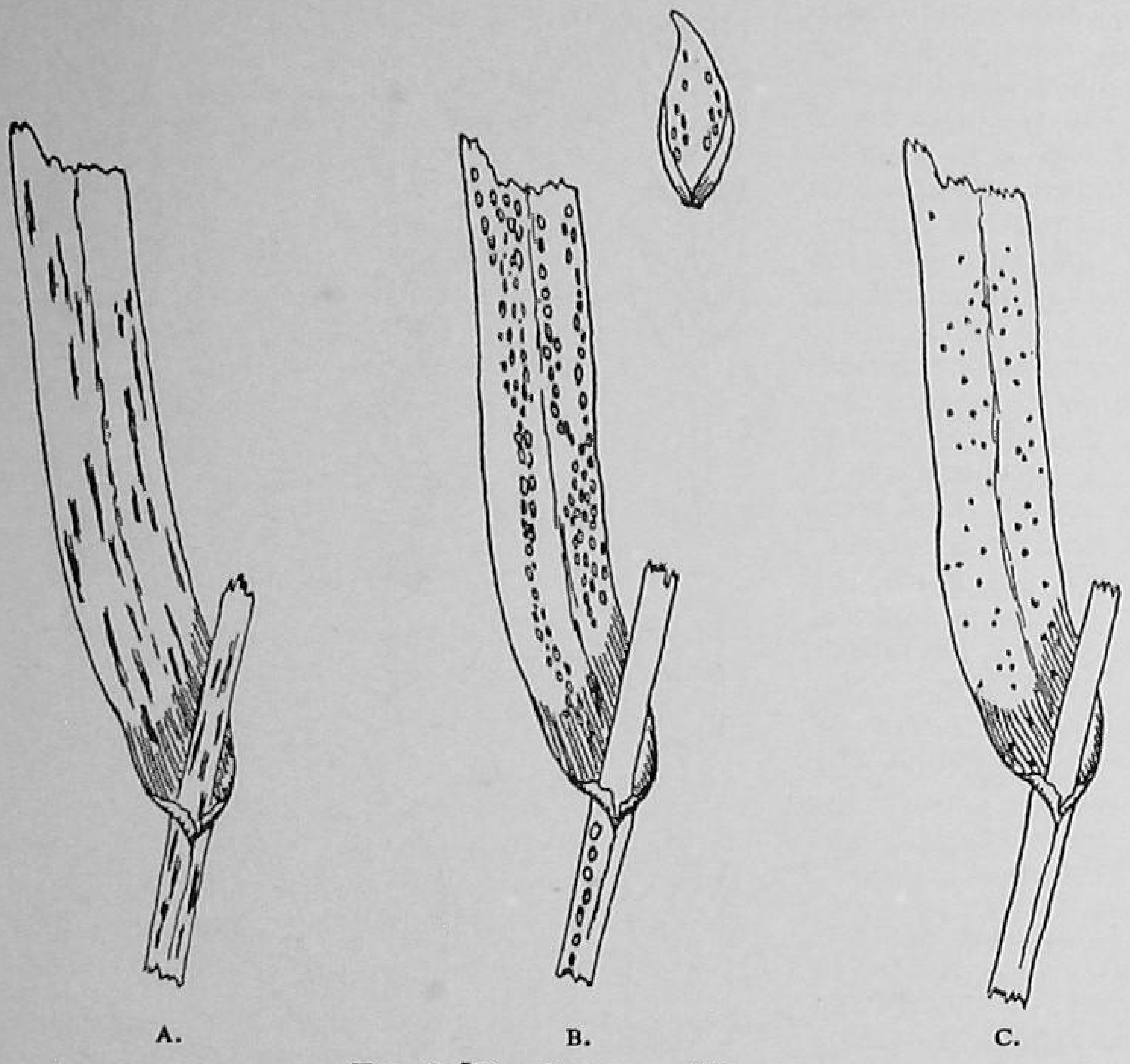

FIG. 8. THE RUSTS OF WHEAT.

A. Black Rust (*Puccinia graminis*). Spore pustules appear in broken lines on leaf and stem. B. Yellow Rust (*Puccinia glumarum*). Spore pustules are grouped into small clusters in parallel lines. Leaves, stem and chaff may be attacked. C. Brown Rust (*Puccinia triticina*). Spore pustules are scattered on the leaf and form no particular pattern.

Even so recently as 1919 or so, Bunt was a common disease, but as a result of effective methods of prevention it is of little account today. Because the spores are on the surface of the living seeds they can be reached with relative ease by fungicides. For many years the fungicide in common use was copper sulphate (bluestone): the seed was steeped in a solution of this and then spread on the barn floor in a thin layer to dry. A reduction of germination often followed, and so bluestone solution was succeeded by formalin, a treatment which was effective and which caused negligible injury. With both of these wet methods, however, the process of application was troublesome and it was necessary to sow the grain very soon after treatment.

The latest advance, dusting with compounds containing mercury in organic form, has superseded the wet methods. With these "organo mercury" compounds, seed can be treated at any time and, provided that storage conditions are dry, no damage results from keeping. For treatment of small quantities of seed, a dusting machine either of the barrel type or of a gravity type may be used. These are relatively cheap to buy and the barrel type is easily constructed on the farm. Many seed merchants have power-driven machines and not only disinfect all cereal seed sent out by them but are also willing to treat the farmer's own saved seed. In either case, the cost is very small compared with the benefits which accrue from this insurance against the risk of Bunt.

Efficacy of control measures to counter the disease is demonstrated by the fact that in 1921–2 one third of the wheat samples examined at the Official Seed Testing Station, Cambridge, were visibly "bunted"; by 1940–1 the proportion had fallen to 1·2 per cent.

LOOSE SMUT OF WHEAT.

In addition to Bunt, there is another disease of wheat in which the grains are filled with masses of black fungus spores. This disease, known as Loose Smut (*Ustilago tritici*), is often confused with Bunt. One of the main differences is that the spore-filled grains burst soon after the ear emerges from the sheath. It is not uncommon to see shattered ears (Fig. 7) standing here and there in a crop perhaps with the black spore masses still pouring from them. Unlike Bunt, the continued existence of the Loose Smut fungus depends upon infection of the seed "elements" occurring while healthy wheat is still in flower. Under favourable conditions, a spore reaching a blossom will send its germ tube into part of the flower. This develops into mycelium which soon becomes dormant. Its presence does not prevent the formation of

the grain which shows no outward sign that the fungus is carried within. If one of these infected seeds is sown, the dormant fungus inside comes to life and (as with the Bunt fungus) the mycelium grows upwards, approximately keeping pace with the growth of the stem. By the time the bulk of the crop is in flower, the spore-filled grains of the infected plants are ready to burst and so the cycle continues.

As infection takes place through the open blossoms by wind-blown spores, prevention at this stage is not practicable. Further, applying a disinfectant externally to the seed (as in Bunt control) is obviously useless, because the fungus is inside. It has been found, however, that the mycelium of Loose Smut is killed at a temperature which does not affect the germination of the seed. Briefly, the method used is to immerse sacks of infected grain in a tank of water which has been brought to a temperature of 125°F.–129°F. and to maintain this temperature for ten minutes by the addition of boiling water. If the temperature is allowed to exceed 129°F. there is a good risk that germination will be affected. The process therefore demands skill and constant attention and an accurate thermometer. Because of these difficulties the process is rarely adopted in commercial practice but is of great value where special breeding stocks are infected. Fortunately, Loose Smut does not reach the epidemic proportions of which Bunt is capable, and should be of little consequence if the farmer always insists on seed from healthy stock. Not all varieties of wheat are equally liable to infection. Among those noted to be particularly susceptible is Vilmorin 27.

Cereal Rusts.

The "rusts" of various plants are members of a group of fungi which are closely related in several ways. The name "rust" is taken from the reddish-brown colour, of spore-containing pustules, which is characteristic of the group. Many rusts have the peculiarity of passing part of their life-cycle on one species of plant and the remainder on plants which belong to completely different genera and even different families.

In England there are three common "rusts" of wheat which have been given the names Black Rust, Yellow Rust and Brown Rust respectively. These names are not completely satisfactory because the fungi to which they refer all have rust-coloured stages in their life histories although that of Yellow Rust has a tint with more yellow in it.

Black Rust of Wheat.

The first marked symptoms of Black Rust (*Puccinia graminis*) are usually seen in summer as rusty-brown blisters running in broken lines along the leaf blade or along the length of the stem (Fig. 8A). These blisters contain masses of spores (uredospores) which burst through the skin and are distributed by wind or by rain splashes. Under suitable conditions uredospores alighting on wheat plants (Fig. 9A) germinate and cause other local infections and more rusty-brown blisters. Towards the end of the summer another type of spore is formed, either in the old pustules or in ones newly developed. These spores (teleutospores) are black and the pustules

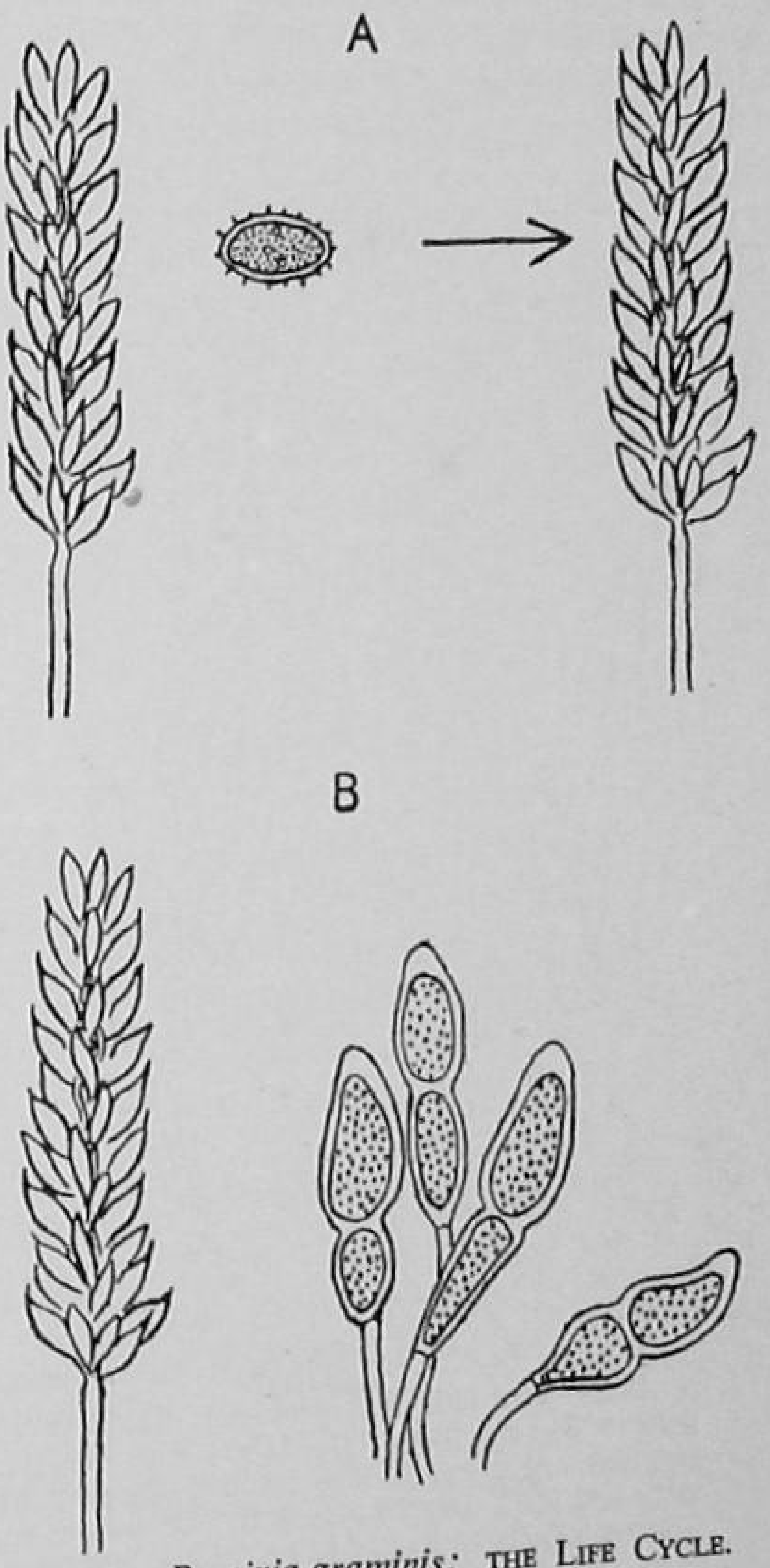

Fig 9. *Puccinia graminis:* The Life Cycle.

A. Uredospores formed on wheat in early summer can infect wheat only. B. Teleutospores are formed on wheat in late summer. They fall to the ground and rest during the winter.

containing them unite to form long black streaks on leaf sheaths and stem. Under the microscope teleutospores are seen to be quite different in shape from uredospores (Fig. 9B). They are the resting spores of the fungus and are capable of resisting the low temperatures of winter. They are widely distributed on fallen or wind-blown fragments of wheat straw from field

and stack. They germinate in spring but cannot infect wheat: instead they choose another host, the common barberry.

On germination (Fig. 9C) teleutospores push out threads which themselves give rise to a third kind of spore (sporidium). These are minute and are easily carried about by air currents. The sporidia are very short-lived and as they are capable of infecting only barberry bushes, it can easily be understood that the vast majority soon die. On the leaves of an infected barberry, orange-coloured pustules (Fig. 9D) are formed and these pustules (aecidia) produce yet another type of spore (aecidiospore) which can infect only wheat. Infected wheat then produces the first kind of spore mentioned, the uredospore (Fig. 9A).

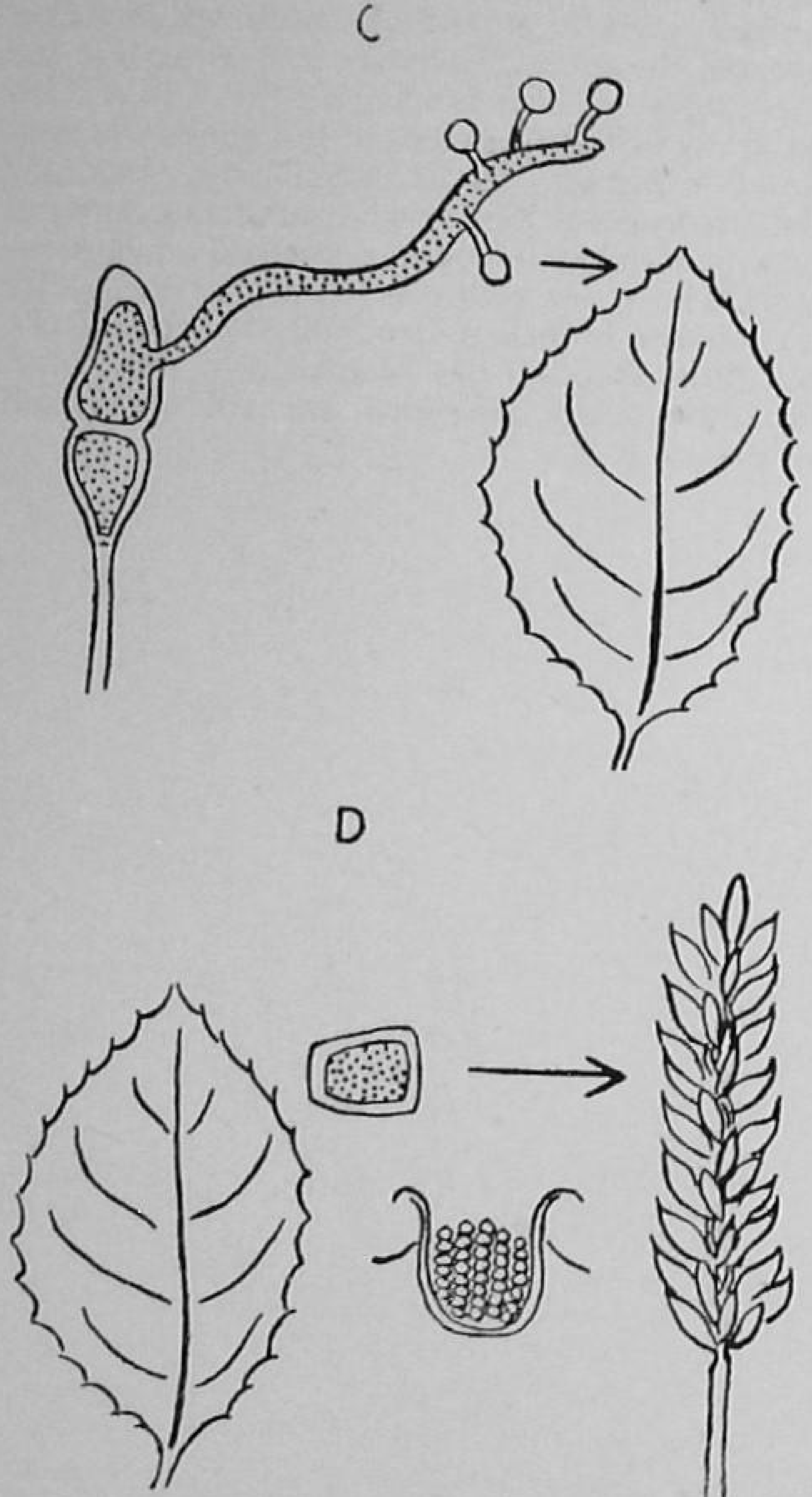

FIG. 9.—*continued.* *Puccinia graminis:* THE LIFE CYCLE.

C. Teleutospores. In spring, teleutospores germinate to produce sporidia which infect the common barberry. D. Aecidiospores from cup-shaped aecidia on barberry leaves infect wheat in early summer.

The life cycle of the Black Rust fungi may may be summarized as shewn in Fig. 9.

It was noted many years ago that barberry bushes had some influence on the incidence of Black Rust, for, where they were present in hedges, it was not uncommon to see zones of severely infected wheat with the bushes as focal points. In some parts of Great Britain there was a deliberate campaign to eliminate the barberry from the countryside and this was followed by a corresponding decrease in Black Rust. The barberry is still abundant in South-west Wales and it is here that the rust is of yearly occurrence.

A break in the life-cycle of the fungus by the elimination of all barberry bushes might be thought to eliminate the disease. Unfortunately, epidemics, though not very frequent, still occur in barberry-free areas and there is little doubt that these usually arise from wind-blown uredospores which may be carried great distances, even from the mainland of Europe. In lands with milder climates than ours, it is known that the fungus can over-winter on volunteer wheat and other host plants, but in Great Britain the temperatures are usually too low to permit uredospores to survive.

Most damage is done when the fungus penetrates deeply into the stem and prevents nutrients from reaching the ear of the maturing wheat; the result is that the grain becomes shrivelled and of a quality too poor for milling.

In addition to wheat, *P. graminis* will attack oats, barley, rye and various species of grasses, although it is rare on barley and rye. There is a very large number of different strains of the fungus (over 200 have been recorded) and each strain, though it is indistinguishable from others in appearance, has individual preferences. For instance, one strain may attack wheat and not oats while another will attack both. More than this, some strains will attack only certain varieties of wheat and not others, but no varieties of the cereal are known to be immune to all strains. The varieties Desprez 80, Wilma and Wilhelmina appear to be particularly prone to damage. This complex relation between strains of fungus and and species or varieties of cereals hinders prevention of the disease by the breeding of new varieties.

Yellow Rust.

Of the other two rusts of wheat which are common in this country, Yellow Rust (*Puccinia glumarum*) is the more important. In some seasons, particularly in cool summers, it has caused great damage. It is earlier than the other rusts and may even be seen in January but it is rarely common till May. Pustules appear not only on leaves and stems but also on the chaff (Fig. 8B). On the leaves they are equally grouped

into small clusters of short parallel lines and a lemon-yellow colour distinguishes their uredospores from those of Black Rust and Brown Rust. Yellow Rust has a winter spore (teleutospore) stage but the alternate host, if one exists, has not yet been discovered. However, in this case the uredospores are able to survive low temperatures and as autumn wheat can be infected quite early, the persistence of the fungus from year to year is understandable. On the other hand, hot summers are liable to kill uredospores. In Britain, the varieties Wilma and Desprez 80 are very susceptible while Rivet, Little Joss, Holdfast, Yeoman, Jubilegem and Bersee show definite resistance. It has been shown that there are several strains of the fungus which show a greater affinity for some varieties. Yellow Rust can attack barley, rye, and certain grasses, but it is not severe on these.

If Yellow Rust becomes a nuisance in any particular district, the most practicable method of dealing with the problem is to grow only those varieties of wheat which are known to be particularly resistant in that district.

Brown Rust.

Brown Rust of wheat (*Puccinia triticina*) is considered to do less damage than either of the other rusts, but its cumulative effect may be more than is generally realized because of its widespread prevalence. Uredospores appear on the leaf blade as thickly scattered brown pustules which are not distributed according to any obvious pattern (Fig. 8C). It is often abundant in July and August, but because leaves are not often killed by the fungus, measurement of the damage done is difficult. Winter spores are not formed freely in Britain and although alternate hosts of the genus *Thalictrum* (rue) enter into the life-history of the fungus in the U.S.A., no naturally infected member of this genus has been found in Britain. Under our climatic conditions the uredospores can survive until late autumn or winter and so infection is possible on autumn-sown wheat. As with other rusts, varieties differ a good deal in their susceptibility to Brown Rust, but little attention has been paid to this aspect because control measures are not considered necessary.

DISEASES OF FRUIT TREES

AMONG the several diseases which infect an assortment of fruit trees and forest trees, two are outstanding as "killers" and often account for the mysterious deaths of individual trees or groups of trees. One of these, *Armillaria* Root Rot, caused by the Honey Fungus (*Armillaria mellea*), works underground; the other, Silver Leaf (*Stereum purpureum*), attacks branches and trunks. A third disease, Brown Rot (*Sclerotinia spp.*), although rarely, if ever a "killer," causes great annual losses to fruit growers, merchants and consumers.

Armillaria ROOT ROT

If a specialist on plant diseases is called upon to explain the dying-off of a group of trees in an orchard, it is not improbable that he will delve about among the roots of the dead trees. If he finds a mass of white mycelium beneath the bark of some of the roots or of the lower part of the trunk his suspicion will have been aroused that death was caused by the Honey Fungus and a search will be made for evidence to confirm it. Such evidence consists of black strands (rhizomorphs), looking like boot-laces, which are sometimes found in the soil surrounding the roots or even attached to the roots themselves. On account of these, the name "Boot Lace Fungus" has been given to the pathogen in the U.S.A.

At any time after July and before the first frosts, but usually in October and November, fructifications are produced above ground. These are about the size and shape of mushrooms and they usually grow in clusters near the base of a dead tree or not far from one. The top of the cap is honey-coloured with dark brown scales. The gills on the underside are "off-white" but unlike those of the mushroom, are attached to the stalk. The stalk is a dull orange or brown, and usually very dark at the base. White-coloured spores are produced in very large numbers on the surface of the gills and are carried about by the breeze.

A curious feature of the disease is that spores do not cause infection to living trees but that they can infect old tree stumps, permeating them with mycelium. It is from these old stumps that the earlier-mentioned "boot-laces" are sent out through the soil towards the roots of living trees. The roots are penetrated by a white mycelium which is developed from the tips of the "boot-laces." The mycelium continues to spread within the roots, often creeping up under the bark at the base of the trunk also. Death of the tree follows. When weather conditions are favourable, the honey-coloured toadstools arise from the dead roots and also from the "boot-laces" which pass between stumps and trees. It is often possible to trace the path taken by the "boot-lace" by following the line of toad-stools which arises at intervals along its length. Once a tree has been killed, it becomes another source from which yet more trees may be attacked. These underground "boot-laces" have been traced reaching out many yards from the dead stumps from which they originated.

From the history of the fungus just given, it will be evident that attacks on healthy trees by *Armillaria* can occur only if there are dead trees or stumps in the vicinity. The presence of these is often forgotten, particularly if they are hidden in a hedge, and it is markedly often near a hedge that the trouble begins. Also, it frequently happens that when unwanted trees are cut down, the stumps are left in the ground for long periods. This can be a costly practice and has resulted in the decimation of many a fine orchard. If a tree has died or is unwanted it should be removed together with as many roots as possible, for even the larger rootlets may act as a source from which the "boot-laces" will go in their search for living trees.

Once *Armillaria* is established in an orchard eradication is difficult and sometimes not practicable. The immediate removal of stumps is of the utmost importance. Even this may not succeed in clearing the ground of all infected roots and these may remain as a menace for some years.

A trench about 2 ft. deep, dug around the site of the infected tree or group of trees, has been advocated as a means of preventing the "boot-laces" from reaching out towards new prey. This may be effective if the trench is regularly cleared of fallen earth which would form a bridge across the void.

A new method of eradicating the fungus, for which success is claimed in the U.S.A., is to inject carbon bisulphide into the soil to a depth of 9 ins. at 18 ins. staggered intervals. Within two months the fungus is said to be killed in the treated area to a depth of 5 ft.

Armillaria is not only able to attack all orchard trees but is notable for the havoc which it causes among forest trees. An authority on forest trees has written that "more trees die, in Europe at any rate, from attack by this fungus then through any other parasitic agent." Trees are the main victims but also are included bushes and herbaceous plants such as black currant, gooseberry, strawberry, raspberry, blackberry and hop.

SILVER LEAF.

The name Silver Leaf has been given to a tree disease, caused by the fungus *Stereum purpureum*, because the first sign of infection is typically a silvery sheen on the leaves. Yet the fungus is not present in the leaves themselves, the sheen effect being due to air spaces beneath the epidermis which has become separated from the underlying tissue. These leaf symptoms follow infection of the woody parts.

The Silver Leaf fungus can attack all kinds of

orchard trees as well as many types of forest trees and shrubs. Apple, plum, cherry, nectarine, peach and apricot are all susceptible as also are beech, birch, poplar and laburnum. The plum variety, Victoria, the cherry varieties Napoleon and Morello and the apple varieties Newton Wonder and Early Victoria seem to have suffered more than other varieties. Pears, although susceptible, are less commonly attacked.

A spore of *S. purpureum* settling on the wounded surface of the trunk or branch of a susceptible tree is capable of germination and of penetrating the wood. If a single branch is attacked then the leaves of it alone will show silvering in the first instance. From this, perhaps within a year or two, the mycelium will probably pass into other branches or even into the trunk itself when all the foliage will take on the characteristic silvery sheen.

A branch bearing silvered foliage usually dies and it is then, and not until then, that fructifications are produced. These burst through the bark and appear on the surface of the dead wood as flattish crusts up to several inches in length or as tiers of bracket-shaped projections up to an inch in width. The spore-bearing surface is smooth and, when moist and fresh, is of a purplish mauve colour. The reverse side is yellowish brown, hairy, and often with zones of different shades. The spores are too small to be visible to the unaided eye; they are easily carried about by air currents.

The fungus is incapable of infecting trees protected by uninjured bark. Pruning cuts and grafting cuts, as well as the breaking of boughs resulting from wind, and the weight of bumper crops, leave exposed wood which, unless adequately and immediately covered with a suitable protectant, invites infection. Soft grafting wax or white lead paint have proved efficient protectants; somewhat surprisingly, the fungus can penetrate a layer of Stockholm tar of considerable thickness.

Not every tree infected by Silver Leaf dies. Recovery will sometimes occur if the tree is in a healthy condition. When the fungus is inside the wood, production of wound gum is stimulated and this may surround the fungus preventing further spread. The gum is seen as a dark stain in the wood of any diseased bough which has been cut through. In summer months, wound gum is produced more copiously than at other times. In fact, in the months of June, July and August, infection through wounds is not likely to occur, because there is rapid protection at the site and so it has been suggested that the cutting back of branches should be done only during those three months.

Infection occurs by means of spores; and as fructifications develop only on dead wood, the destruction of all dead trees and branches is of paramount importance in orchard hygiene. To this end, the Silver Leaf Order of 1923 requires the occupier of any premises on which plum or apple trees are growing to destroy by fire on the premises all dead wood of each plum or apple tree before the 15th of July every year. Where the dead wood is in the trunk and extends to the ground, the whole tree, including the roots, must be burnt. For his own and his neighbour's good he would be well advised voluntarily to adopt the same measure with the dead wood of other trees.

Thus, in controlling the disease, it is essential to destroy all dead wood. On the other hand, the grower may leave a living branch on which silvered leaves have appeared in the hope that it will recover. This is less likely to happen with plum than with apple. If the branch is sawn off, the cut should be made well behind any brown stain in the wood and flush with a larger branch or with the trunk. The surface of the cut should be smoothed and immediately covered with grafting wax or white lead paint. If all the leaves on the tree are silvered, the best course is to uproot it and burn it.

A white lead paint which has proved suitable for the protection of pruning cuts is made up as follows:—

To 2 lbs. white lead paste (as bought) add two teaspoonfuls of paste driers and two tablespoonfuls of linseed oil. Mix. Then add two tablespoonfuls of turpentine and mix well.

Brown Rot of Tree Fruits.

The name Brown Rot is descriptive of the damage done to the fruits of many types of orchard trees by the two species of fungus *Sclerotinia fructigena* and *S. laxa*. The same name has also been used to include the damage done by the same fungi to parts of the tree other than the fruit. Rotting, accompanied by brown discolouration of the flesh, is to be seen in the fruits of apples, plums, pears and cherries nearly every year in nearly every orchard. It is particularly a feature of plum and apple orchards at picking time where, when the crop is heavy, the ground may be littered with fruits which are brown and rotten and which have light brown (*S. fructigena*) or grey (*S. laxa*) pustules on the surface. These pustules, which are often arranged concentrically, are the fructifications of the fungus. Each fructification is made up of closely packed chains of lemon-shaped spores.

Brown Rot more than any other disease or condition is the cause of rotting in stored apples, pears and peaches and must be familiar to the most unobservant. Spores are not readily produced on stored fruits but the rot increases from small centres of infection which were too small to notice at picking time. Further spread of the fungus is then mainly by contact between diseased and healthy fruits.

Although particularly noticeable in late summer and autumn, the disease is by no means confined

to ripe fruit; infection and spore production may begin in spring and continue copiously throughout the summer months. The spores, being light, are easily wafted by air currents from tree to tree and from orchard to orchard, so spreading infection. In the fruit this usually takes place through a wound. Frost cracks, hail injury, scab wounds or insects punctures all provide sites of entry. The mycelium will pass between fruits in contact and in this way whole clusters become diseased.

Some of the fruits which have been infected by the Brown Rot fungi are soon invaded by saprophytic organisms. The flesh then becomes mushy and decays. With others, the mycelium penetrates all parts of the flesh causing shrinkage, followed by mummification. These mummied

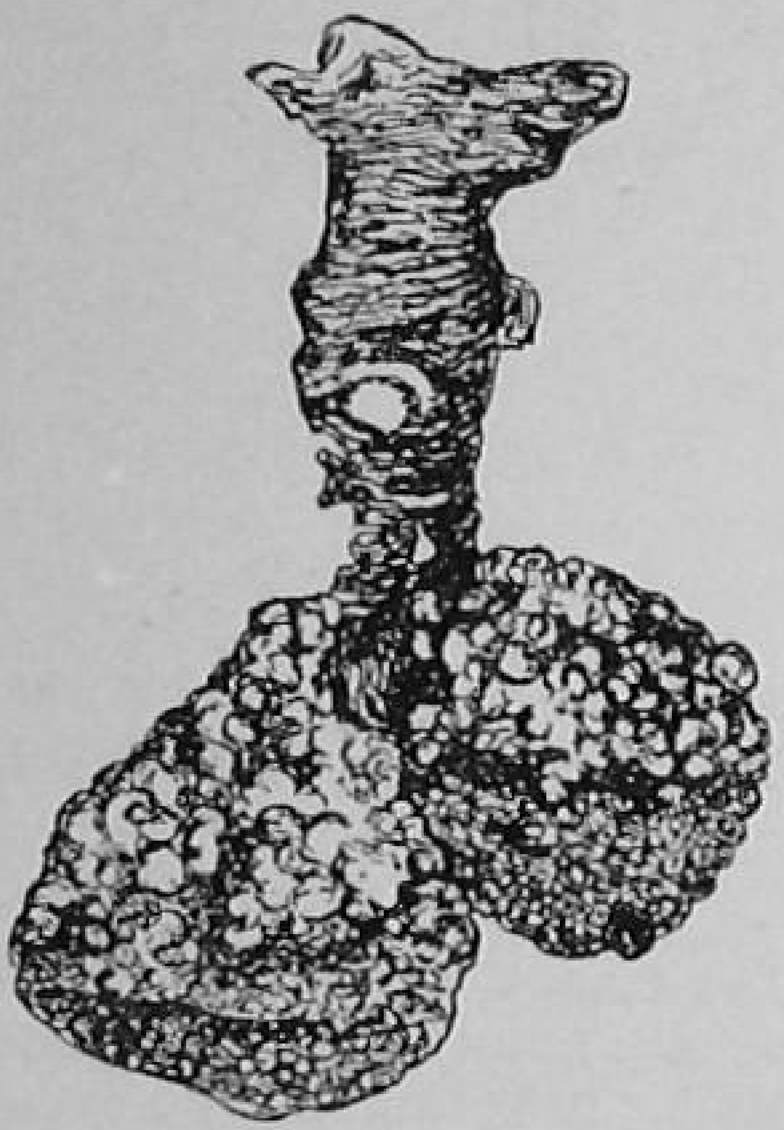

FIG. 10. BROWN ROT OF APPLES.
Mummied fruits showing spore pustules produced in spring.

fruits are to be found on the ground and also hanging on the trees (Fig. 10). In this condition they persist through the winter, although spore production ceases until the following spring, when it once more becomes active.

Spurs, Shoots and Blossoms.

In addition to fruits, other parts of the tree may be attacked. Thus in apple, the mycelium of *S. fructigena* passes down the fruit stalk to the spur, which it kills. In plum, *S. laxa* sometimes attacks young leaves, the mycelium passing down the leaf stalk and killing the sappy shoots or spurs. It may also pass from the leaves into older twigs causing cankers. In apple, plum, cherry, pear, peach, nectarine and apricot, it is capable of entering the blossoms causing Blossom Wilt and passing through the flower stalks to the spurs which are cankered or killed.

Measures which prevent or reduce the amount of Brown Rot differ to a certain extent with the type of tree attacked and the form of damage occurring. Nevertheless, the basis of treatment common to all forms of the disease is the same—the removal of the sources of infection. Mummied fruits should be knocked off the trees in early winter. Diseased spurs and shoots, which also produce spores, should be cut off as soon as recognized and all of these "spore factories" should be burnt. Where Blossom Wilt has occurred it is an advantage to cut off the infected shoots or spurs bearing them as soon as possible; if left until winter, recognition of the infected wood is difficult. With tall trees, the removal of "mummies" and twigs may be difficult, but the attempt is worth while, particularly if brown rot is a local problem. Of prime importance in the disease in apple fruits is the control of Scab and also of insect pests particularly Codling Moth.

Cherries are particularly liable to suffer from Blossom Wilt and subsequent infection of the wood. It is probably the worst disease of Morellos on which, in some years, most of the blossoms may be killed; it gives the tree an appearance which might be expected after a bonfire had been lighted underneath. A degree of protection against Blossom Wilt is given by spraying immediately before the flowers open. Either lime sulphur (1 in 50) of Bordeaux mixture (6:8:100) may be used for sweet cherries, but Bordeaux mixture is safest with Morellos, as they are liable to be injured by lime sulphur.

APPLE SCAB AND PEAR SCAB.

Twenty or thirty years ago a high proportion of apples and pears seen in fruiterers' shops often bore black superficial scabs which were not only unsightly but sometimes caused a distortion in the shape of the fruit. In more recent years such fruit would have been unsaleable or would have fetched very low prices. The disappearance of these blemishes is the result of preventive measures which have been evolved at research stations in the fruit-growing areas.

The fungus which causes Apple Scab (*Venturia inaequalis*) does not attack pears, and the fungus which causes Pear Scab (*Venturia pirina*) does not attack apples. The habits of the two fungi are similar, but differences may be distinguished under the microscope.

On the Fruit.

Fruits may be infected at any stage of development (Fig. 11). Small dark spots first appear and these increase in size. Underneath each spot is a pad of tangled mycelium and from this arise numerous short stalks. Slipper-shaped spores (Fig. 2C) are produced at the tips of the stalks and, *en masse*, these give a sooty appearance to the centre of the spot. Spores blown or splashed about start other infections. If young fruits are infected they either fall or become badly deformed

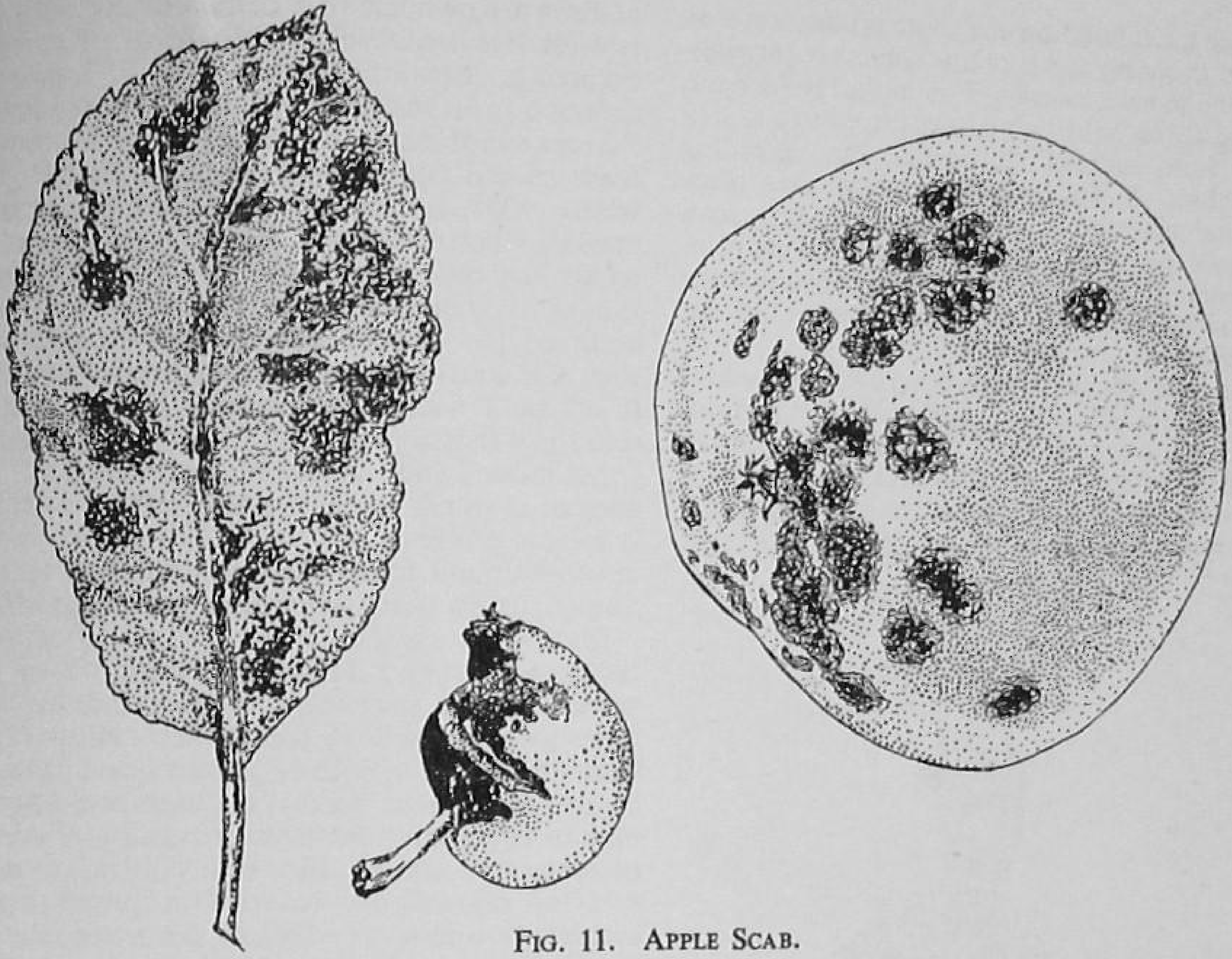

FIG. 11. APPLE SCAB.

Left: Leaf with brown or olive-green spots of sporulating fungus. *Centre:* Fruitlet which has been distorted by early infection. *Right:* Full-sized fruit with typical dark spots following infection.

(Fig. 11). When attack does not take place until the very end of the season, the spots may not be visible at the time of picking but may develop during storage and this is known as "Storage Scab."

Fruit spotting is the best known and most damaging stage of the disease, but young shoots, buds and leaves are also affected and these are the source from which the fungus begins activity in the spring.

Young shoots which have been infected in the summer months produce blister-like swellings the following spring. These swellings result from small pads of mycelium which increase in size until they burst through the bark. Short spore-bearing stalks arise from the surface of these pads giving them an olive brown colour. If weather conditions are suitable spores are carried to the leaves and germinate to produce brown or olive coloured spots (Fig. 11) on which more spores are produced. As well as passing the winter in the shoots, the mycelium of the fungus can over-winter in the fruit buds, and it is not uncommon for the first signs of the disease in spring to be seen on the rosette of leaves surrounding a flower bud. A third source of infection in spring is the fallen leaves of the previous year which have rested beneath the trees all the winter. In the tissue of these, minute fructifications are developed. These fructifications differ from those on which spores are produced at the tips of short stalks. They consist of flask-shaped receptacles, each containing numerous sausage-shaped spore sacs (Fig. 2C). In spring the spore sacs elongate towards the mouth of the receptacle and burst to release the spores.

Thus it will be seen that the Scab fungus can overwinter in three ways: on young shoots, in fruit buds and in dead leaves. From these three sources, spores are produced in spring to affect growing leaves and from the leaves the fungus attacks the fruits.

Scab pustules on the shoots act not only as a source from which spores are disseminated, but they also provide wounds through which the fungus of Canker (*Nectria galligena*), a disease of the wood, may enter.

No variety of apple or pear is immune from infection but the degree of susceptibility differs. The famous dessert varieties of apple, Cox's Orange Pippin, Worcester Pearmain and Laxton Superb are liable to severe damage, while certain other varieties including King Edward VII are resistant. Among pears, Fertility is particularly susceptible.

The control of Scab is one of the major routine operations of fruit growers. Removal of scabbed shoots is, of course, desirable. Destruction of fallen leaves would be helpful but is doubtfully practicable. Reliance is placed on spraying and

this is very effective. A schedule, timed in relation to blossom development, has been evolved and this should be closely followed.

The preparation in greatest favour for Apple Scab control is lime sulphur. This should be applied to the trees with a power sprayer

FIG. 12. APPLE CANKER.

Left: Young twig showing peeling of bark and death of buds. *Right:* Infected branch with shrunken bark around snag which was probably the point of infection.

at the following times and at the following strengths:—

	Time	Strength
1st application	green cluster	$2\frac{1}{2}$% (1 in 40)
2nd ,,	pink bud (when buds are showing pink)	$1\frac{5}{8}$% (1 in 60)
3rd ,,	petal fall, when 80% of the petals have fallen	1% (1 in 100)
4th application	fruitlet stage (when fruits are the size of marbles	1% (1 in 100)

The fourth spray is sometimes omitted, but should be given if the fungus has been particularly active. A few varieties of apple are very sensitive to damage by lime sulphur under any conditions: others are sensitive in certain localities only. Stirling Castle should never be sprayed with lime sulphur. Lane's Prince Albert, Beauty of Bath, Rival and Duchess's Favourite should not be sprayed after blossom. With these, pre-blossom applications may be sufficient, or it may be found that certain proprietary preparations will not cause damage.

The control of Pear Scab is similar to that of Apple Scab and spraying is done at corresponding times.

The varieties Doyenne du Comice and Dr. Jules Guyot are sensitive to lime sulphur and should be sprayed with colloidal sulphur after blossom. As Pear Scab is often more difficult to control than Apple Scab it is worth using $2\frac{1}{2}$ per cent lime sulphur for both pre-blossom sprays where damage is not likely to occur, but to drop to $1\frac{1}{2}$ per cent after blossom. Most pear varieties (except Doyenne du Comice) are uninjured by Bordeaux mixture and as this is, if anything, a better killer of Scab than are sulphur-containing sprays, may be used instead throughout at a strength of 8:12:100. For instructions on making Bordeaux mixture, see p. 824.

APPLE AND PEAR CANKER.

The cutting out of cankers in apple and pear trees is a time-absorbing routine familiar to every fruit grower, but not everyone realizes that there are several different causes of canker. In modern usage, however, the term " Canker " is understood to refer to wounds caused by the fungus *Nectria galligena.* The importance of the disease is aptly summarized in a review of Diseases of Crop Plants during a ten year period in which it is stated that " Canker was common everywhere each year but the more severe attacks usually occur in low lying places and where the soil is heavy."

A typical canker on the branch of an apple or pear tree is seen as a sunken elliptical area surrounding the stub of a dead twig (Fig. 12). Concentric ridges on the surface give it an appearance suggestive of an oyster shell. In long-formed cankers, the bark may flake off leaving the wood exposed. If the canker girdles the branch, death of the part terminal to it rapidly follows.

Infection cannot occur unless the bark is injured. Pruning wounds, breaks in twigs and branches, frost cracks, insect injuries, scars left by fallen leaves and wounds due to Scab all

provide places through which the fungus may enter.

Two kinds of fructification are produced. On newly formed cankers, pustules push through the bark. Masses of minute spores, mixed with a gummy exudate are produced on the surface of each pustule and give an appearance reminiscent of blobs of candle grease. Rain drops wash and splash the spores to other parts of the tree while insects and birds carry them to other trees. As a canker gets older, cracks form in the dead bark and in these fructifications of a second type (perithecia) often develop. The fructifications are spherical red bodies about $\frac{1}{50}$ of an inch in diameter, each with a small aperture at the top through which spores ooze in a slimy mass. These red fructifications are often mistaken for the eggs of insects.

Cankers are to be found on apple and pear trees of all ages and all varieties, but some varieties are more susceptible than others. In apples, Cox's Orange Pippin, James Grieve and Worcester Pearmain are notably susceptible while Bramley's Seedling and Newton Wonder are more resistant. In pears, Fertility is particularly prone to attack by Canker (as well as by Scab).

When twigs and small branches are cankered, they should be cut off at a place well below the canker. When a large branch or the trunk itself is attacked, the canker, if operated on early enough, may be cut out, care being taken to remove all infected wood. Cut surfaces should be covered with white lead paint to protect them from entry by *N. galligena* or other disease-causing fungi. A great deal may be done to prevent Canker in the orchard by avoiding damage to trees, damage which is particularly likely to happen at picking time. All pruning cuts should be covered with white lead paint.

Measures taken to prevent Scab also indirectly reduce the risk of infection by the Canker fungus which, as pointed out above, often enters wounds caused by Scab.

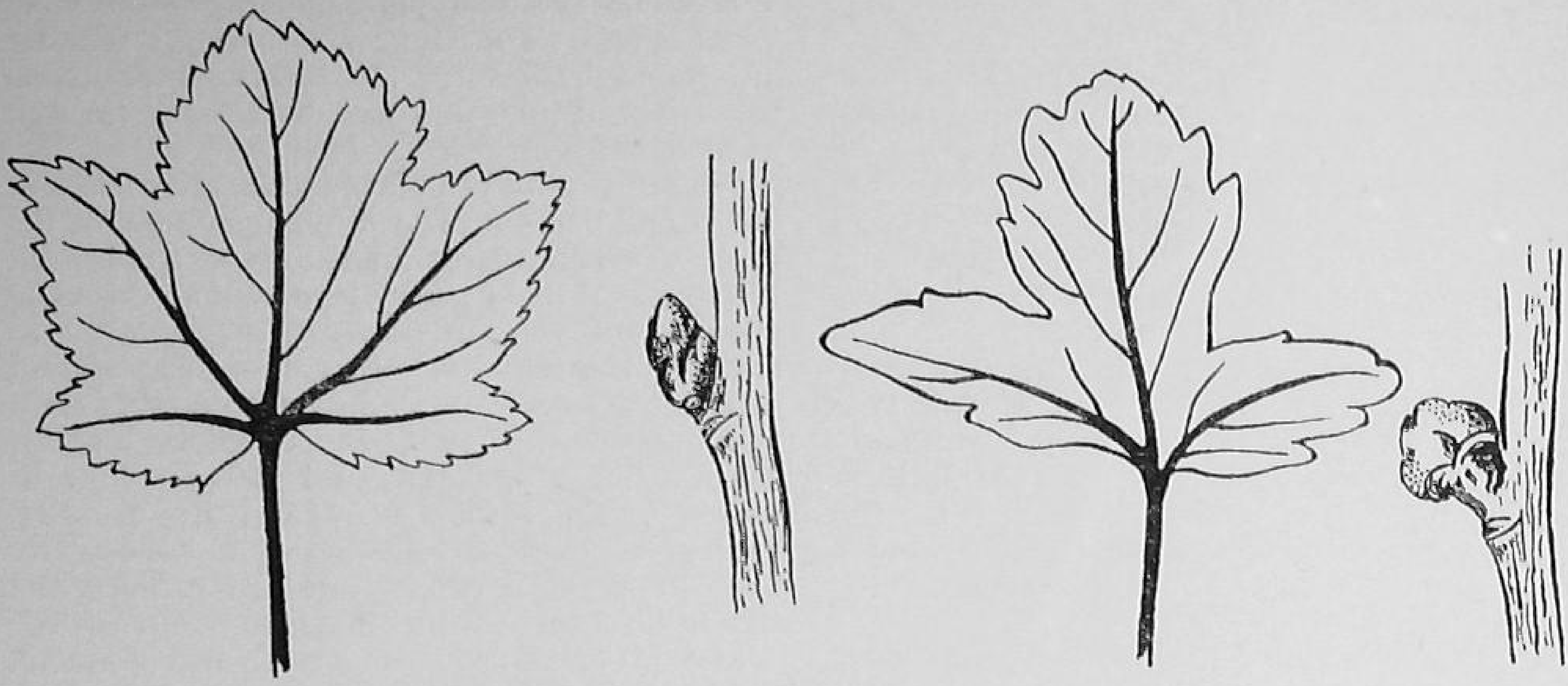

FIG. 13. VIRUS REVERSION AND BIG BUD IN BLACK CURRANTS.

Left: Leaf and bud from healthy bush. The leaf has five main lobes and also numerous marginal teeth. *Right:* Leaf from infected (" Reverted ") bush with only three lobes and three main veins. The swollen bud (Big Bud) is infested with mites.

SOME VIRUS DISEASES OF SOFT FRUIT

BLACK CURRANT REVERSION.

OLD age in plants does not necessarily have the same significance as old age in animals. This is particularly so with plants that are propagated vegetatively rather than by seed. In this way an individual plant may be divided into many pieces and the pieces widely distributed. Each of these pieces in its turn is developed into another large unit or plant and pieces of this are again divided and distributed. This process may go on for many years and in a sense the stock may be regarded as becoming older. For instance, every potato tuber within a variety may be regarded as a part of the single plant which was originally raised from a true seed, and it was not unreasonable to attribute the reduced vigour or " running out " which overtook many of the stock of older varieties to the effects of senility. As is now known, the main factor is not age but the presence of one or more viruses. Similarly, all members of any one variety of black currants are essentially parts of a single plant; and a virus disease, known as " Reversion " is sometimes propagated with the cuttings. This virus does not produce symptoms of a type familiarly known to herald disease or even old age. Rather, alteration in leaf shape and habit of growth, together with unproductiveness gives an appearance which in the minds of many was near to that of a " wild " bush and it was thought possible that the selected pedigree stocks had reverted to uncultivated ancestral types. The cause is now known to be a virus but the name " Reversion " has stuck.

The first signs of the disease are not prominent. Leaves of an infected plant are somewhat narrower and darker than those of healthy plants. If the disease is sufficiently advanced an alteration in the number of veins and lobes of the leaf gives more concrete evidence. A leaf blade from the vigorous shoot of a healthy plant has five lobes—a large central lobe and two smaller ones on each side. Running from the leaf stalk to each main lobe is a large vein with smaller veins running from it. The five main lobes and the five main veins are best seen by examining the under surface of the blade (Fig. 13).

The corresponding leaves from a " reverted " shoot will have less veins and lobes (Fig. 13). Further, the leaves of healthy bushes bear numerous teeth at the margin; when reversion is present these are coarser and fewer in number. Before coming to a conclusion on diagnosis, it is well to examine several leaves, because similar alterations in leaf parts may follow earlier injury to the buds from which the shoots came. Such injury is not uncommon on shoots from bushes which have been severely cut back. When symptoms of " False Reversion " arise from these causes, the bush rapidly returns to normal growth.

A bush infected by reversion virus bears a decreased crop of fruit and may cease fruiting altogether. Infection may spread not only with cuttings from a diseased bush, but may also be carried from diseased to healthy bushes within the plantation. There is good evidence that the Big Bud Mite (*Eriophyes ribis*) is the insect responsible (vector).

Big Bud (Fig. 13) is a well known phenomenon in the black currant plantation. As the name implies, the presence of the mite stimulates the buds to swell to a size larger than normal. The mites are to be found between the bud scales in vast quantities.

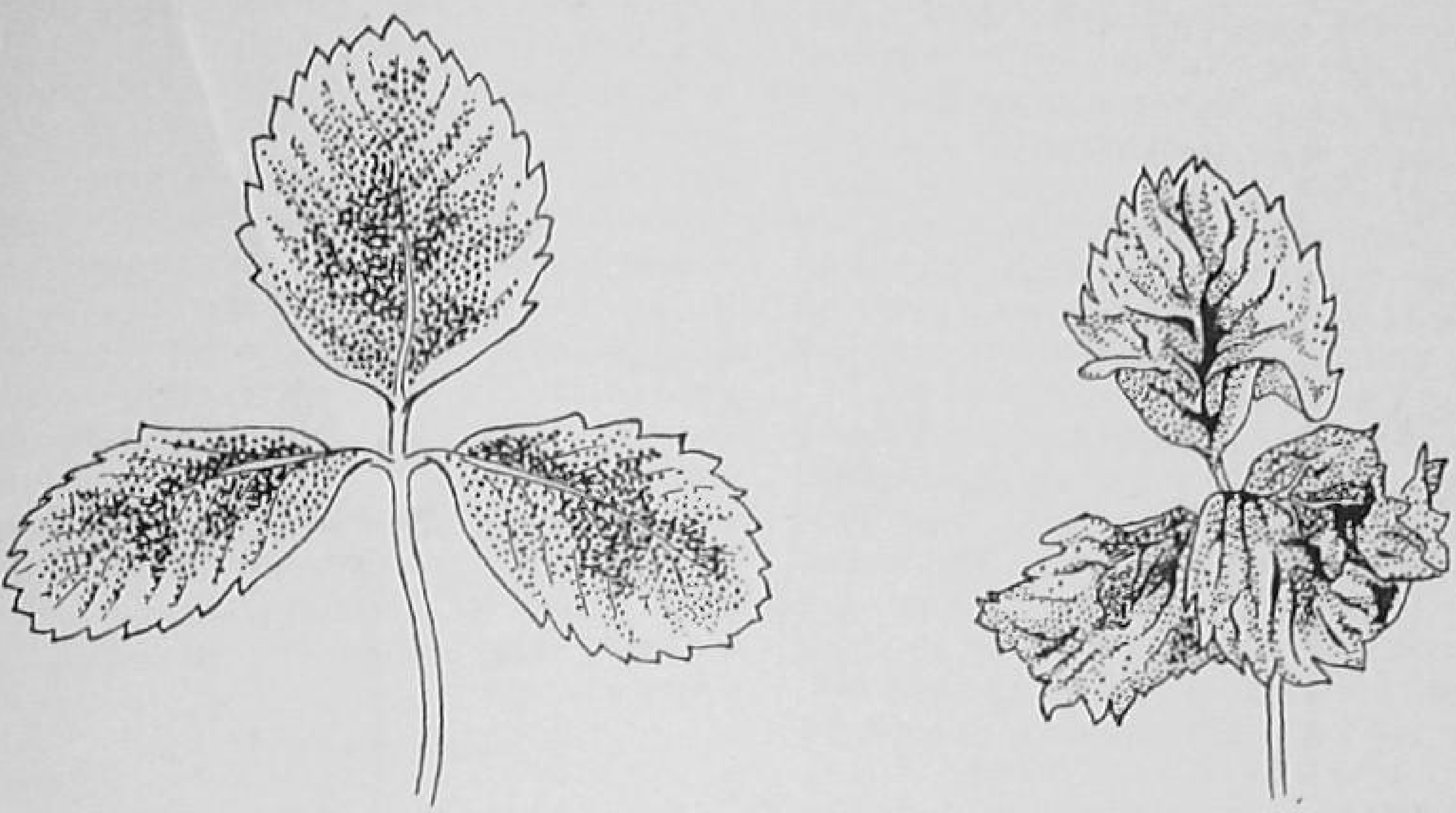

FIG. 14. STRAWBERRY VIRUS DISEASES.
Left: Yellow Edge. The margins of the leaflets are yellowish; at a later stage cupping of the blades will occur. *Right:* Crinkle.

Satisfactory methods of control of Reversion have evolved from the known history of the disease. In starting a new plantation, only those stocks should be used which have been examined and certified by the Ministry of Agriculture. If reverted bushes are found in a plantation, they should be immediately uprooted and burnt. Cuttings should be taken only from healthy stock. Big Bud mites should be kept in check by spraying with lime sulphur (1 in 50) just before the flowers open. If a plantation is badly affected by Big Bud the strength of the spray may be increased to 1 in 20 for the first year though this may cause scorching in some varieties. In a small plantation, the mites may be kept down by picking off the swollen buds.

STRAWBERRY VIRUS DISEASES.

Most people in these Islands who take the trouble to compare the flavours of different varieties of strawberries will be emphatic that Royal Sovereign is the best for dessert. As so often happens, what is good is also difficult to grow, and Royal Sovereign is no exception.

The main cause of the difficulty is virus disease or rather, a number of virus diseases. These diseases reduce to a greater or less extent the cropping power of most strawberry varieties, but the choice variety, Royal Sovereign, becomes very sickly when infected and so the problem has been particularly emphasized. If a plantation is badly infected by a virulent strain of any of the viruses, it might just as well be destroyed because to keep it tended will certainly be uneconomic.

For practical purposes, two virus diseases have been distinguished and these are named respectively Yellow Edge and Crinkle. The names have been selected as roughly descriptive of the main symptoms, but there is good evidence that, as with most viruses, several strains exist and that a mixture of two or more on the same plant is common.

Plants of Royal Sovereign infected by the Yellow Edge virus become stunted and bear few fruits. In the cool weather of autumn the margins of the leaves (beginning with the young central leaves) become yellow (Fig. 14). The leaf blades become "cupped" and the leaf stalks are shortened. This latter feature gives the plant a flat appearance.

With Crinkle, in addition to stunting, small pale spots appear on the leaf-blade and, since only the tissue between the spots can continue development, the effect is to produce a wrinkled or crinkled leaf (Fig. 14). These spots must not be confused with almost universal spots with brown centres and red margins which are caused by a fungus (*Mycosphaerella fragariae*) and which do little harm.

The present method of propagating strawberries naturally propagates the virus too. As it is the nature of most viruses to spread to all tissues (systemic infection), the runners from a diseased strawberry are certain to be infected and as with potatoes, this perpetuation of the viruses is responsible for "degeneration." In fact the stocks "run out."

The variety Sir Joseph Paxton, together with a few others less popular is, like Royal Sovereign, very sensitive to Yellow Edge. On the other hand, the varieties Huxley, Madame Lefebvre, Oberschlesien and Early Cambridge are capable of carrying the virus without showing marked symptoms and can so thrive and yet be a reservoir of disease without proclaiming the fact by their appearance. It is clear that plants of this tolerant group should not be planted near those which are

sensitive. The varieties Tardive de Leopold, Western Queen and Cheddar Early belong to an intermediate group and should be grown in plantations removed from plants in the other two groups.

Both Yellow Edge and Crinkle viruses are transmitted from diseased to healthy plants by the sap sucking Strawberry Aphis, *Capitophorus fragariae*. Other aphides visit strawberries but apparently are not vectors.

Virus diseases have interfered with strawberry growing to such an extent that a scheme for the certification of strawberry stocks has been welcomed by commercial growers. The scheme provides for the inspection of growing plants and for the issue of certificates relating to those which have proved to be true to type and substantially free from virus diseases. Growers of strawberry stocks for sale to growers of fruit crops may themselves obtain stocks having a Special Stock Certificate. Such Special Stocks are raised under very stringent conditions of control. A special virus-free strain of Royal Sovereign has been selected and great care is taken to keep the nuclear stocks free from virus infection. The selection is known as Malling 40 (M.40). Pedigree stocks of other varieties are Huxley M.44 and Oberschlesien M.42.

Raisers of certified plants and of special stocks must comply with rigid conditions and have their plantations inspected.

The commercial grower, and the amateur, can do a great deal to avoid loss by purchasing only certified stocks and by not planting varieties within one virus group close to varieties within another. It is important to keep down the aphis population by spraying or dusting with a preparation of nicotine; runners may also be freed from aphides by dipping them in nicotine before planting. Removal and destruction of plants showing symptoms of disease should be a routine. The best times for inspection and roguing are from Mid-May to Mid-June and again from Mid-September to October. With proper precautionary measures, there is a good chance of maintaining a strawberry bed for five or six years without great loss from virus diseases.

Raspberry Mosaic.

Mosaic of raspberries presents a problem very similar to that caused by virus diseases of strawberries. There is more than one strain of the Mosaic virus and symptoms range from dark and light green patches on the leaf to sharply-defined yellow spots on a green background. These may be accompanied by leaf distortion and a stunting of the plant.

As with strawberries there are great differences of reaction to infection between one variety and another. Certification schemes are in operation and cane nurseries have been established.

DISEASES OF TOMATOES

TOMATO culture in Britain is an attempt to grow a sub-tropical plant in a temperate climate.

Outdoors, planting cannot be done until the fear of frosts is over and this must be followed by severe pruning to check too ambitious growth of foliage. Under glass, control of temperature and moisture is possible but length of daylight is uncontrollable and the first plants to be set out must adjust themselves to short days and long nights. As tomatoes are the chief glasshouse crop in this country, the same soil patch is commonly expected to bear tomatoes year after year and the benefits of rotation are withheld.

With all these cultural disadvantages, it is not surprising that tomatoes are temperamental and liable to attract many and varied diseases. Only strict attention to the details of hygiene will ensure a reasonable measure of success.

Before 1940, growing outdoors was hazarded by a few market gardeners in the South and by private gardeners. During the war the acreage became relatively large. With the prospects of imports from sunnier lands it has shrunk again. The revival of outdoor growing has brought a reminder that Blight (*Phytophthora infestans*) does not confine its attentions to potatoes. This disease infects foliage and fruit of tomatoes. On the leaves the symptom is similar to that on potatoes. On the fruit a small grey or black spot is seen under the skin near the point of infection; this increases in size until a large part or the whole of the flesh is black and infected. Blight usually begins much later on tomatoes than on potatoes. Its onset can be prevented by spraying with home-made Bordeaux mixture but late applications are liable to leave a blue deposit on the fruit. Many growers are content to put up with this disadvantage for the privilege of protection.

The fungus *Alternaria solani* has long been known in U.S.A. as the cause of a serious disease called Early Blight on account of its appearance early in the season. It was not recorded for certain in Britain until 1944 when it was found to have caused severe damage on several outdoor plantations in the South. On the leaves, infection causes black spots each of which typically has a series of concentric ridges (Fig. 15). This gives rise to the name Target Spot. *Alternaria* blight, like the common Blight is not often found in glasshouses. *A. solani* also causes spotting of the stem and rotting of the fruits. The latter is often confused with rotting by *Didymella lycopersici*.

A third outdoor disease of tomatoes is Bacterial Canker (*Corynebacterium michiganense*). Further mention of this is made on p. 831.

Perhaps the best known disease of glasshouse tomatoes is Leaf Mould, *Cladosporium fulvum*. This is very common and will cause premature defoliation of a crop and so reduce the yield and quality of the fruit. Control of *C. fulvum* is perhaps more a problem for the glasshouse designer than for the plant pathologist. It is doubtful whether the fungus would make serious headway without a humid stagnant atmosphere. In the meantime, however, palliatives exist in the form of copper and sulphur-containing sprays.

DAMPING OFF AND FOOT ROT OF TOMATOES.

The related fungi *Phytophthora cryptogea* and *Phytophthora parasitica* can attack the tomato plant on stem and roots at any stage of growth but they are most notorious as the causes of "Damping Off" of young plants. Seedlings are said to have "damped off" when they topple over and shrivel up following attack on the stem by a fungus (Fig. 16). Usually a small group in the box is at first affected; the group becomes larger until every plant is involved. Each affected stem will be seen to have a pinched appearance

FIG. 15. *Alternaria* BLIGHT OF TOMATO. Zoned spotting on leaf (Target Spot).

at soil level due to a shrinkage of tissue. Collapse occurs at this point. Often plants become infected just before they are ready for setting out in their permanent quarters in field and glasshouse and the injury is too slight to be noticeable at the time. Within a few days of planting out, however, the tissue at the base of the stem shrinks and even if it is by then woody enough to keep the plant upright, the flow of nutrients between roots and foliage is checked and death ensues.

Every year, thousands of plants infected in this way are sent out by nurseries where hygiene has been faulty and, in consequence, many acres of tomatoes are lost even before the plants have become established in the soil.

In the more mature plant, a shrunken brown scar develops on the stem at the place of infection, usually at the base (Foot Rot). If the stem is girdled, the foliage wilts and the plant dies. Root infection commonly accompanies Damping Off and Foot Rot but it can occur alone. Healthy tomato roots, after washing under the tap, should be firm and white in colour; after attack by *Phytophthora* they become brown and collapsed. The plant may throw out fresh roots to replace those which have died, but these in turn will certainly become infected.

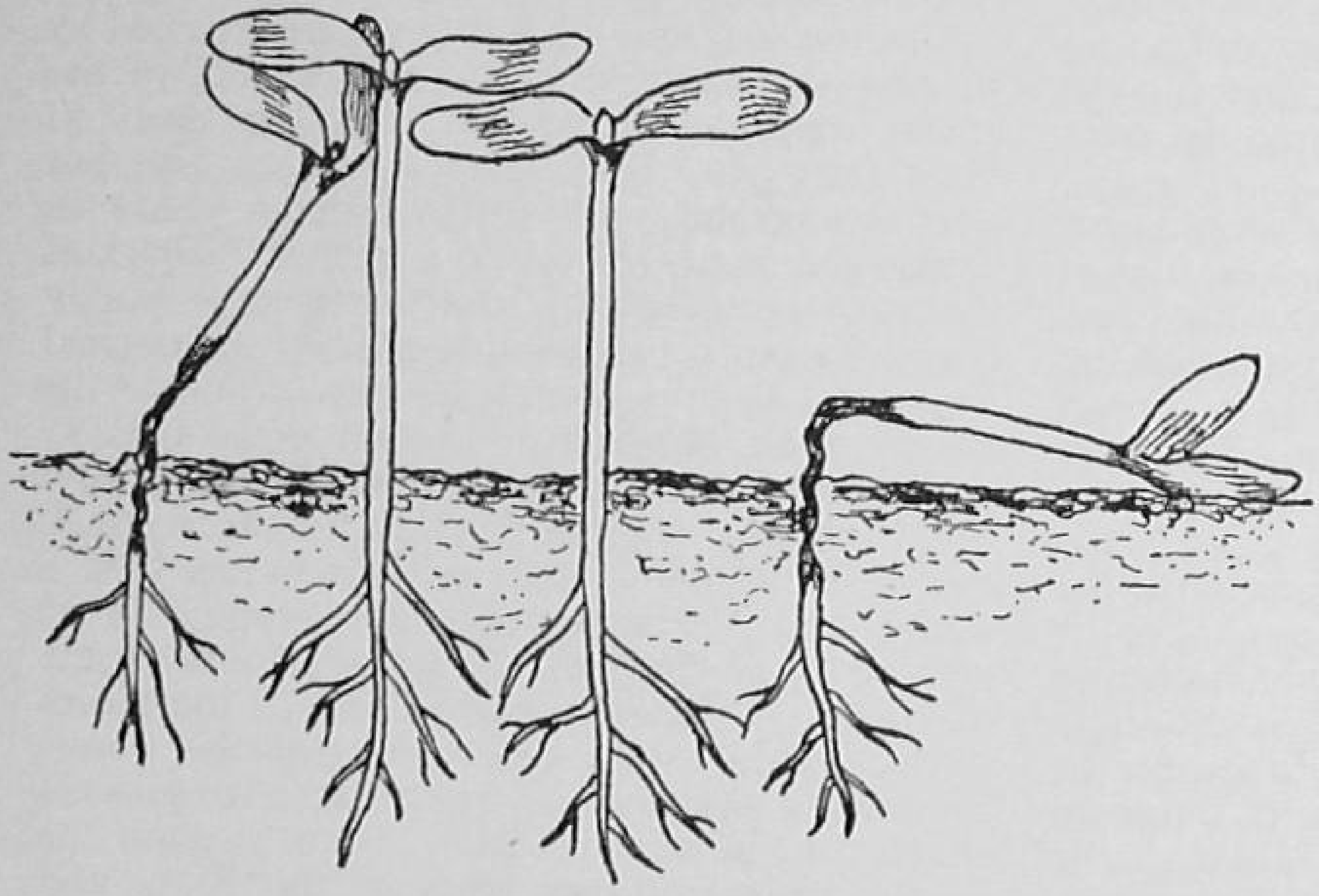

FIG. 16. "DAMPING OFF" OF SEEDLINGS.
Tomato seedlings infected at soil level by one of the Damping Off fungi.

As is to be expected, the different species of the genus *Phytophthora* have many points in common. Some of these relate to the appearance of the fungus as seen under the microscope; others relate to habit. Of the later, one of the most important is the need for abundant moisture for growth and reproduction. With *P. infestans* (the cause of Blight of potato and tomato) it was seen that the fungus was usually spread from plant to plant by swimming spores and that the disease was therefore severe only in moist weather. Similarly, *P. parasitica* and *P. cryptogea* are spread from plant to plant by swimming spores which demand wet conditions for development and spread. But unlike *P. infestans*, the other species are rarely seen with the naked eye because, besides being minute, the fungal growth rarely comes to the surface of the plant except at or below soil level.

P. cryptogea and *P. parasitica* are normal inhabitants of some soils. They are also to be found in ponds—a reminder of their aquatic leanings. From these considerations it is clear that the fungus may be introduced to a nursery with soil which has been imported for making composts or it may exist in a nearby pond which is used for watering. Quite often, the trouble is introduced with purchased plants from another nursery. But whatever the original source, it is certain that once the soil of a nursery, or its water supply, has become contaminated, the prospects of raising tomatoes are poor unless steps are first taken to kill the fungus.

Except when infected plants are used, the danger of losses from Root Rot and Foot Rot is small in outdoor plantations. In glasshouses, on the other hand, where conditions favour the diseases, the inclusion of certain hygenic measures in the annual routine is of the utmost importance. Before sowing or planting tomatoes, the soil should be treated as though it were known to be infected. Clean sand and peat of the moss or sedge type are unlikely to be contaminated and when used in seed or potting composts do not require to be disinfected. Soil, on the other hand, should be sterilized with heat or with a suitable chemical substance before it is added to the other components.

Sterilization by steam has proved to be the best method of all, for not only does it kill parasitic organisms but it also increases fertility. Quantities of soil for potting may be steamed at low pressure with simple apparatus, but for the efficient treatment of beds in the glasshouse steam must be injected into the soil to a depth of not less than 18 inches until a temperature of 212°F. is reached in all parts. For this operation a boiler and pipes are required; various practical methods are detailed in Bulletin No. 22 of the Ministry of Agriculture to which the reader is referred.

Although soil sterilization by steam is the ideal, few amateur gardeners or small holders will be prepared to go to the expense and trouble involved and chemical methods must be adopted. Among these formalin is cheap and effective.

The soil to be treated should be saturated with

a 5 per cent solution. Small quantities for potting should be made into heaps about 4 ft. high, each 6 inch layer being saturated as the heap is built up. The heap is then covered with sacks for 48 hours, after which it is spread thinly on a concrete floor or on clean ground so that the gaseous contents of the formalin may escape to the air. The soil is ready for use when the smell of formalin can no longer be detected. About half a gallon of the dilute formalin will be required for each cubic foot of soil.

Beds in the glasshouse should be dug over as deeply as possible and all lumps broken. The dilute formalin should then be applied at the rate of 2–5 gallons to each square yard and the doors closed for 24 hours. This is followed by thorough ventilation. Planting may be safely done when all smell of formalin has disappeared. The actual time will depend on several factors including the type of soil and the temperature within the house. Two to six weeks is common. As a safeguard it is a good plan to set out a few test plants in the treated beds. If these survive after four or five days, the house may be considered safe for planting up.

In addition to soil, pots and boxes should also be sterilized, for these may harbour the fungus in a dormant state for many months. Pots and boxes may be sterilized, after being washed, by steeping in 5 per cent formalin, piling in a heap and covering with sacks for 24 hours. They can then be left uncovered in an open shed until the vapour has gone.

If *Phytophthora* diseases occur, even after the precautions outlined above have been taken, it must be supposed that the operation of sterilizing has not been done thoroughly or that the fungi have been introduced from an outside source. In sterilizing soil it should be constantly borne in mind that every particle must be raised to the right temperature or be reached by the fumes from the formalin. If this is not done, the fungus will rapidly spread from the infected particles to the rest. Too often the process is regarded in the nature of a mystic ceremony to lay the ghost.

Emphasis has been given to the devastating effects of *Phytophthora* in glasshouses. All hope of a crop need not be abandoned, however, if infection, when detected, is confined to small areas and the bulk of the crop is uninfected. Healthy plants may be protected against attack by saturating the soil around them with a solution of Cheshunt Compound. Treatment may be given to boxes of seedlings or to more mature plants without doing any damage. Instructions for the preparation of Cheshunt Compound are given on p. 825.

The risk of contamination from water is avoided if the supply is taken direct from the main. If water is stored in tanks it is essential that they should be kept clean and free from plant debris.

Verticillium Wilt of Tomato.

Among the large assortment of fungi which inhabits the soil are members of the genus *Verticillium*. Two parasitic species in particular of this genus, namely *V. albo-atrum* and *V. dahliae*, are capable of infecting a number of different plants including tomato, potato, raspberry, strawberry and chrysanthemum. With tomatoes, *Verticillium* Wilt is primarily a disease in glasshouses where it is responsible for great losses every year; it is of less account outdoors where crop rotation can more economically be practised. *V. albo-atrum* produces more pronounced symptoms and is more injurious to the plant than *V. dahliae*. In fact investigations on the relation of the latter species to disease has only recently begun in Britain but it seems likely that its presence in glasshouse soils may well have accounted in part for hitherto unexplained crop reductions.

The first sign that a plant has been attacked by *V. albo-atrum* is a limpness and wilting of the lowest leaves during the hot part of the day. At night there may be a temporary recovery; but after a time the lower leaves become yellow in colour and finally shrivel. If a strip of the bark of the stem is peeled off, the under-lying woody tissue is seen to be brown instead of the normal white of a healthy plant. Discolouration of the woody tissue is alone no certain proof that *V. albo-atrum* is the cause of the wilt because other fungi and bacteria can produce a similar effect, but in combination with leaf symptoms it is a useful guide. The presence of mycelium of *V. albo-atrum* in these woody strands confirms the diagnosis. It may be that wilting of the leaves is due partly to the obstruction of the water-conducting system and partly to the poisons which the pathogen releases. From the soil the fungus gains entrance through the roots and passes to the stem. Successive cropping with tomatoes encourages a " build-up " of the parasite in the soil and unless preventative measures are adopted, tomato growing becomes impossibe.

The most successful preventive measure is partial sterilization of the soil by steam. This treatment will free a sufficient depth of soil to allow one or two years of comparative freedom from attack, but the process must be repeated at intervals because there will almost certainly remain some living *Verticillium* in the lower levels or in some spots where the temperature has been insufficiently high. From such sources, the whole of the bed will gradually become reinfected.

While prevention is obviously the best course to adopt, an infected plant may frequently be induced to reach maturity and become fruitful by altering its environmental conditions. The manager of an infected crop may be pardonably surprised when he receives the advice to cease watering the roots and to raise the air temperature in the glasshouse to 77°F. for a few days. At the

same time it is desirable to shade the plants from the direct rays of the sun by splashing whitewash on the outside of the glasshouse and to give an occasional spray with water to the foliage to keep the atmosphere humid without damping the soil.

There is insufficient information available to be able to say much about *V. dahliae* but the indications are that infected plants may show no obvious outward symptoms of attack or perhaps only a slight wilting of the top leaves during hot sunny periods. It is not improbable that several strains of each species of fungi exist and that these provide a range of forms which include those incapable of infecting a tomato plant and those which are rapidly lethal.

Tomato Root Rots.

When a sickly tomato plant is lifted from the soil, the roots more often than not are found to be discoloured and rotting instead of being white as in a healthy plant. The rotting may be the result of attack by *Phytophthora cryptogea* or *P. parasitica*, fungi which cause diseases already described and which are known to be deadly parasites capable of infecting plants even when

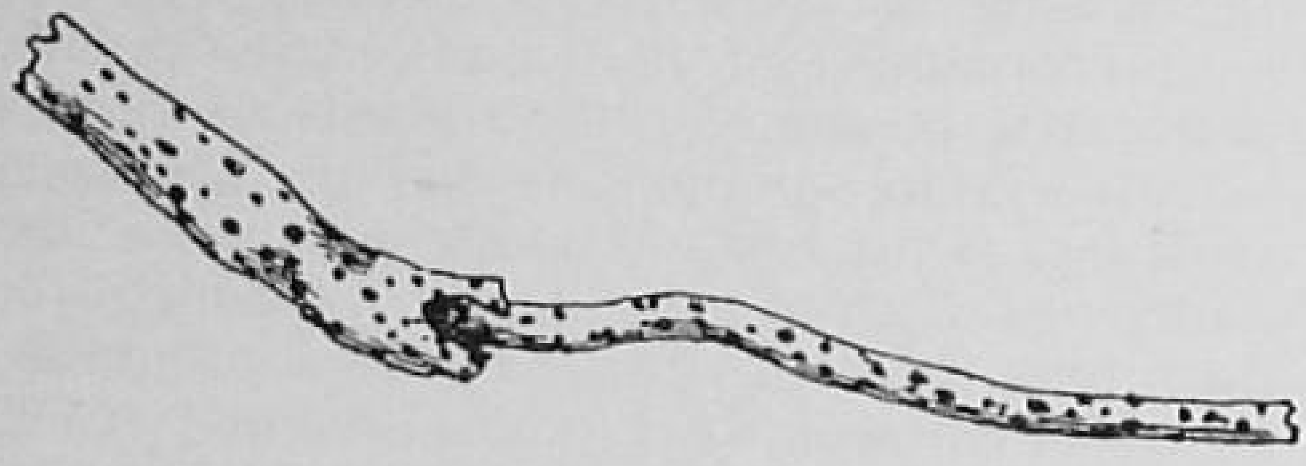

Fig. 17. Black Dot of Tomato.

Piece of diseased tomato root with outer sleeve of tissue (cortex) removed from part of fibrous core (stele). Both are covered with small black resting bodies (sclerotia).

grown under ideal cultural conditions. In addition, there are soil-inhabiting fungi, less strongly parasitic, which usually attack only the roots of plants which have received a check in growth for some reason. Of these, *Colletotrichum atramentarium* and *Thielaviopsis basicola* are the commonest. One or both are present in the soils of many (perhaps most) glasshouses and of many outdoor plantations.

Roots infected by *C. atramentarium* have a characteristic appearance and this aids the identification of the disease. A healthy tomato rootlet has a fibrous core (stele) which is covered by a sleeve of softer tissue (cortex). After infection by *C. atramentarium* not only does the rootlet become brown but the sleeve of tissue, which was firmly attached, readily slides off the fibrous core (Fig. 17). Another feature of the fungus which aids identification is its habit of forming black bodies (sclerotia); these are smaller than a pin's head but are just visible to the unaided eye. Under conditions favourable to them they are formed in large numbers and are seen embedded in the surface of infected roots and sometimes also in the fibrous core. It is by means of these bodies that the fungus can persist in the soil in a resting state. After a time, and in the presence of moisture, masses of spores are produced on the surface of each, ready to begin new infections of nearby susceptible roots. *C. atramentarium* besides being a parasite on the living roots of tomatoes causes a similar root rot of potatoes and on both hosts it has the descriptive name of Black Dot disease. Its saprophytic habit is shown by the fact that it can grow on pieces of straw; it also commonly grows on the below-ground parts of dead tomato plants at the end of the season after the crop has been harvested.

Roots attacked by *Thielaviopsis basicola* are usually girdled at intervals by bands of brown dead tissue, the lengths between the bands being of a normal white. Under conditions of moisture, vast quantities of shortlived colourless spores are produced. Later on, dark-coloured spores (chlamydospores) (Fig. 2E) are developed in and on the diseased tissue and these serve to keep the fungus alive for long periods. *T. basicola* is known as a root disease of other cultivated plants, notably of peas and tobacco.

Some plant-pathologists consider that these two root-rotting fungi can be strongly parasitic on tomatoes while others have concluded that they are only weakly parasites. This difference of opinion might well be explained by supposing that there are several different strains with different degrees of ability to attack the roots. However this may be, it is certain that if a tomato plant is growing under conditions which check healthy development, then the roots are most likely to become infected by one or the other. Soils in poor physical condition, or those that are badly drained, resist root action and predispose roots to disease. These root rots are also found where there are deficiencies of essential nutrients such as magnesium. Furthermore, attack most often occurs when the plant is already infected by other diseases and often accompanies *Verticillium* Wilt and the several virus diseases. It is quite true that if the fungi were not present in the soil, then the roots, however prone, could not be attacked and there would be no more root rot. A treatment of the soil by steam or formalin similar to that recommended in the treatment of the *Phytophthora* diseases is useful in reducing the amount of root rotting fungi even if it does not succeed in eliminating them, but primary consideration should be given to other factors such as the correction of poor soil conditions, and the control of other diseases.

Didymella.

Stem Rot and Fruit Rot.

For many years before 1938, Stem Rot and Fruit Rot of tomato, caused by *Didymella*

lycopersici, were uncommon diseases except in Lancashire and Cheshire, but from 1938 onwards there has been a rapid rise in the losses incurred through attacks by the fungus. It became widespread throughout the tomato-growing areas of England during the war years, and " *Didymella* " is now a word which depresses the spirits of growers of outdoor and glasshouse tomatoes alike. The fear is based on the knowledge that considerable losses can result from an attack and also on the knowledge that, however small the infection, there are no really effective measures to prevent spread of the disease throughout the whole crop. Further, once it has appeared, there is every prospect that it will reappear from year to year.

D. lycopersici can infect plants at all stages of growth, but it is most familiar to the nurseryman, on stems of large plants and on fruits from outdoor plantations. On the stem, the place of attack is usually at soil level where a sunken brown patch develops. This patch increases in size and frequently girdles the stem, so that the plant is killed. Under favourable conditions the fructifications of the fungus can be seen (best with a magnifying glass) as numerous minute black bodies, no larger than pin pricks, imbedded in the surface of the brown patch. If this surface is moistened, a mucilaginous tendril will exude from a pore in the centre of each black body (Fig. 2B). Each tendril contains myriads of spores (to be seen only under a microscope) and they are held together by the mucilage. These spores are easily distributed from plant to plant by water splashes or by insects. (In addition to stem and fruit, the leaves and certain parts of the blossoms can be infected, but the injury inflicted is then of less importance.)

Fruit Rot.

Fruit Rot occurs in quantity in outdoor plantations only. In these it can cause very heavy losses, particularly among the last half of the crop to be harvested. The rot begins as a spot with a water-soaked appearance in the " dimple " where the fruit is attached to the stalk. The spot becomes dark brown in colour as it increases in size and if decay of the flesh is sufficiently deep the fruit separates from its stalk and falls to the ground. Often, infection occurs just before picking and it is not until the fruit has been boxed for a day or two that the rot progresses far enough to be noticed.

Before the war years the disease was not of sufficient importance to call for the employment of special measures of control, but during the war years, not only did it " flare up," but it caused serious losses in the greatly increased tomato crops both outdoors and in glasshouses. The problem of control, which has been under investigation for the last few years, has been found to present difficulties which are not yet fully overcome. Nevertheless it is possible to reduce the risk of spread by adopting certain measures.

Control.

Once established, the disease can spread rapidly. It is therefore essential that infected plants should be uprooted and burnt immediately they are detected. In this way spread is likely to be reduced but not prevented, for by the time the symptoms have been noticed, some spores will already have been set free. From the fact that attack is usually at the base of the stem, it seems probable that spores are splashed about from the soil during watering. Attempts have been made to counter this by covering the base of the stem with a protective deposit of a fungicide or other substance, but the results have been disappointing.

Tests have shown that *D. lycopersici* can overwinter on pieces of old tomato plant and will also grow on hay, straw, rotten wood, raffia and leaf mould. From these, spores can be produced as soon as conditions are suitable the following spring and summer. It is therefore a sound plan to kill the fungus in the glasshouse during winter when there is no crop to impede operations. By the time the last tomatoes have been picked from a crop containing infected plants, there will be an abundance of spores on the plants themselves, on the surface of the soil and on the superstructure of the house. So the first move is to destroy as much of the fungus as possible before disturbing the soil. This may be accomplished by burning flowers of sulphur at the rate of 1 lb. for each 1,000 cubic feet of house before clearing out the old crop. The plants should then be uprooted and burnt without delay, giving no time for more fructifications to develop. Next, further reduction of the fungus on the surface of the soil is made by spraying with 2 per cent formalin. Having dealt with above-ground contamination, attention must be paid to infection below the surface. Pieces of plant tissue harbouring the fungus and spores will have been washed down or worked into the top few inches. These should be destroyed by sterilizing the soil by means of steam or formalin. This treatment has for some years been a routine practice with many nurserymen as a precaution against the various root-rotting and damping off fungi which so readily attack tomatoes and which have already been described in this section.

During winter months, spores of *D. lycopersici* have been trapped at various heights above ground-level both in the glasshouse and outdoors. Taking into account the multitude of spores which can be produced by a single minute fructification this is not surprising. Outdoor plantations must provide a huge reservoir of these air-borne spores, but even in districts where only indoor growing is the practice, some of the living fungus will have been carried outside during the summer in various ways, such as on the boots of workers and on implements.

Air-borne spores are supposedly an important way in which the pathogen is introduced to a clean house. To deal with any which might have settled on the soil, surface sterilization as near as possible to planting time has been advocated. In many cases, this is about a fortnight before. After closing down the house, a solution of 2 per cent formalin should be sprayed onto the beds and paths with a power sprayer, using one gallon of the solution to each square yard. The house should be heated during the seven days before planting to aid release of the formaldehyde gas from the treated soil. During the operation of planting it is well to avoid all unnecessary walking in and out of the house; a suggested plan is for one worker to carry the plants to the door of the house where they can be received by another worker who remains inside.

Measures for preventing or delaying initial infection of *D. lycopersici* have been discussed in some detail. They may strike the reader as elaborate, but until more is known, are well worth carrying out efficiently in glasshouses where the disease has already occurred. Attacks to be most feared are those on young plants, because death is more rapid and the prospects of wholesale spread are greater. Thus, even if prevention is impossible, disaster may be avoided by delaying initial attacks.

Seed-Borne.

The exercise of the hygienic measures suggested above might be wasted effort if seed from diseased fruit were used, for recently it has been shown that *D. lycopersici* may be carried with seed. Infection at the seedling stage can readily follow and this would give a crop the worst possible start.

With outdoor tomatoes the same principles of prevention apply, but individual factors are not as readily controlled as in a glasshouse. Soil sterilization is rarely practicable and, even if carried out, the chances of reintroducing the fungus from surrounding sites are infinitely greater. The best that can usually be done is to remove and burn infected plants as soon as they are recognized and to uproot and burn all plant material as soon as the harvest has been completed.

On Stakes.

An outstanding source of infection is stakes or canes from a previous infected crop, if new stakes are not used the old ones should first be soaked for 48 hours in a 5 per cent solution of formalin.

TOMATO VIRUS DISEASES.

Like its close relative the potato, the tomato is very liable to infection by viruses and is indeed the virologist's happy hunting ground. The subject of virus diseases was introduced to the reader by considering Mosaic disease of tobacco and it was pointed out that the same virus is responsible for Mosaic disease of tomato.

TOMATO MOSAIC.

There is a number of strains of this virus causing diverse symptoms. The range is probably very long, so that between the mildest form and the severest there is a gradual progression. But for practical purposes, the different visible manifestations of disease have been given the descriptive names of Mosaic, Yellow Mosaic, Enation Mosaic and Streak. With the mildest form, a mottle of light and dark green appears on the youngest leaves about ten days after the plant has been infected and all subsequent growth will show similar markings. There may not be any serious reduction in development of foliage or of crop. This form of the disease is very common in glasshouses.

Yellow Mosaic has also been called Aucuba Mosaic on account of the yellow and white patches which appear on the leaves and which have been compared with the pattern on the leaves of the aucuba laurel. In addition, growth is checked and fruits develop yellow ring-like markings and blotches.

Enation Mosaic is distinguished by extreme malformation of the leaves. The leaf blade is much reduced and the small leaflets may curl spirally. Outgrowths (enations) appear on the under surfaces of the leaves. Few fruits set and these are usually of poor quality.

Streak refers to the longitudinal brown or black streaks on stem and leaf stalk which are a feature of the symptoms produced by this strain of the virus. Leaf mottle may also be present and sunken brown marks appear on the fruit. Sometimes a plant is also infected with potato virus X and together the two viruses will cause death of the plant; if it lives the effects become very pronounced and the markings on the fruit are raised instead of sunken. This form has been called Mixed Streak.

All strains of Mosaic virus are very easily spread by the transference of sap from an infected to a healthy plant. No insect vector is necessary. The constant handling of tomato plants in a glasshouse assists an epidemic if a single infected plant is present. Quite how the first infections begin each year in each glasshouse is not known, but there are several ways in which it could occur.

For instance, the virus will live several months in the dead tissue of diseased plants and some of the debris from a previous crop is almost certain to be present in the soil of the house. There is evidence that the roots of healthy plants may be infected from this and although the virus does not necessarily travel upwards to the foliage there may be conditions under which it does.

Secondly, it has been found that some samples of tobacco contain the virus in an infective condition so that the juice on the fingers of smokers can start the disease. Thirdly, there is a

possibility of its being carried in the seed-coat, although whether such seed can produce an infected plant is still controversial.

A great deal more of investigational work must doubtless be done before fully effective control measures are evolved. Nevertheless, from what is already known, certain steps may be taken to prevent the worst effects. If only a few plants in a house show symptoms, they should be removed and destroyed, but it is likely that by the time the trouble is seen other plants will already be infected. When a high proportion of plants show Mosaic it is perhaps best to leave them undisturbed and be content with a reduced crop.

As might be expected, the sooner infection occurs, the greater will be the loss of yield. It is therefore incumbent upon growers to reduce, as far as possible, risks of early infection.

In this connexion, the use of seed from uninfected plants is an obvious precaution, whatever views may be held on the question of seed transmission.

Next comes the problem of root infection; to reduce this risk, debris from a finished crop should not be left on the ground for digging under, but should be collected and burnt. However carefully done, this operation is not likely to be fully efficient and some pieces of dead leaf are liable to escape notice. If steam sterilization is carried out, this might inactivate the virus where the heat is sufficient, but it is not " killed " unless subjected to a temperature of 90°C. for 10 minutes and it is doubtful whether every part of a glasshouse border reaches this.

Thirdly, if " no smoking " during the growing season is considered too much of a hardship, it might at least be arranged that a tobacco " fast " be kept by the worker dealing with seedlings and young plants.

Finally, unfavourable soil conditions seem to encourage the virus to spread rapidly from the point of infection to the remainder of the plant (systemic infection). Treatments which might bring this about include the application of manures or lime in excessive amounts and erratic watering.

Spotted Wilt.

The name given to this disease is of little help in its identification. An affected plant is not always spotted and it rarely shows signs of wilting.

Symptoms are variable according to the conditions under which the plants are grown. Usually, the first symptom is a down-curling of the youngest leaves and these assume a glossy surface either black or bronze in colour or the surface may be covered with irregular chocolate-coloured spots. Slightly older leaves then develop black or brown spots which may coalesce to form patches of dead tissue and may even involve the whole leaf.

Infected plants are stunted and do not recover. No cultural treatment seems to help them.

One of the reasons that Spotted Wilt is difficult to eliminate from the nursery is that the virus infects over a hundred other host plants and on some of these does not show very marked symptoms of disease. Further, the virus is carried from diseased to healthy plants by the species of *Thrips* so common in glasshouses, *Thrips tabaci*. Among the many host plants are Begonia, Browallia, Calceolaria, Callistephus (Aster), Campanula, Celery, Chrysanthemum, Cineraria, Dahlia, Datura, Gloxinia, Hippeastrum (Amaryllis), Lettuce, Lupin, Nasturtium (Tropaeolum), Primula, Richardia (Arum), Salpiglossis, Szhizanthus, *Solanum caspicastrum*, Trachelium and Zinnia. The list also includes the weeds Black Bindweed, Broadleaved Plantain and Woody and Black Nightshades.

It is not uncommon to find infected ornamental plants or weeds in the same glasshouse as tomatoes. Perennials such as dahlias and arums will provide a perpetual source of infection.

The first step in controlling the disease is to remove and destroy all infected tomato plants. A search should be made for weeds and these also destroyed. Ornamental plants in the same house should be examined for yellow spotting or mottling with or without distortion and dwarfing. Such plants may be infected and if practicable should be removed.

Thrips must be killed by fumigation or spraying with nicotine or a preparation of D.D.T.

Fern Leaf.

The name " Fern Leaf " is descriptive of a symptom which may result from infection by either the cucumber mosaic virus or by certain strains of tobacco mosaic virus but it usually applies to the former. The Cucumber Mosaic virus infects cucumbers and also a number of other host plants. When tomatoes become infected the leaf blades become thread-like. Transmission is by aphides. The disease is only found to any extent in outdoor plantations.

SOME DISEASES OF VEGETABLES

Now we shall give the outlines of a few of the common diseases of vegetables. These particular diseases are selected both to serve as illustrations of the variety of disorders which happen and to give facts about the diseases themselves.

Club Root of Brassica.

Club Root or Finger and Toe are fanciful names descriptive of the symptoms of one of the most widespread and serious diseases of the cabbage family. Cabbages, cauliflowers, Brussels sprouts, kale, turnips, swedes and certain other members of the *Cruciferae*, such as wallflowers and charlock, are susceptible. Roots of an

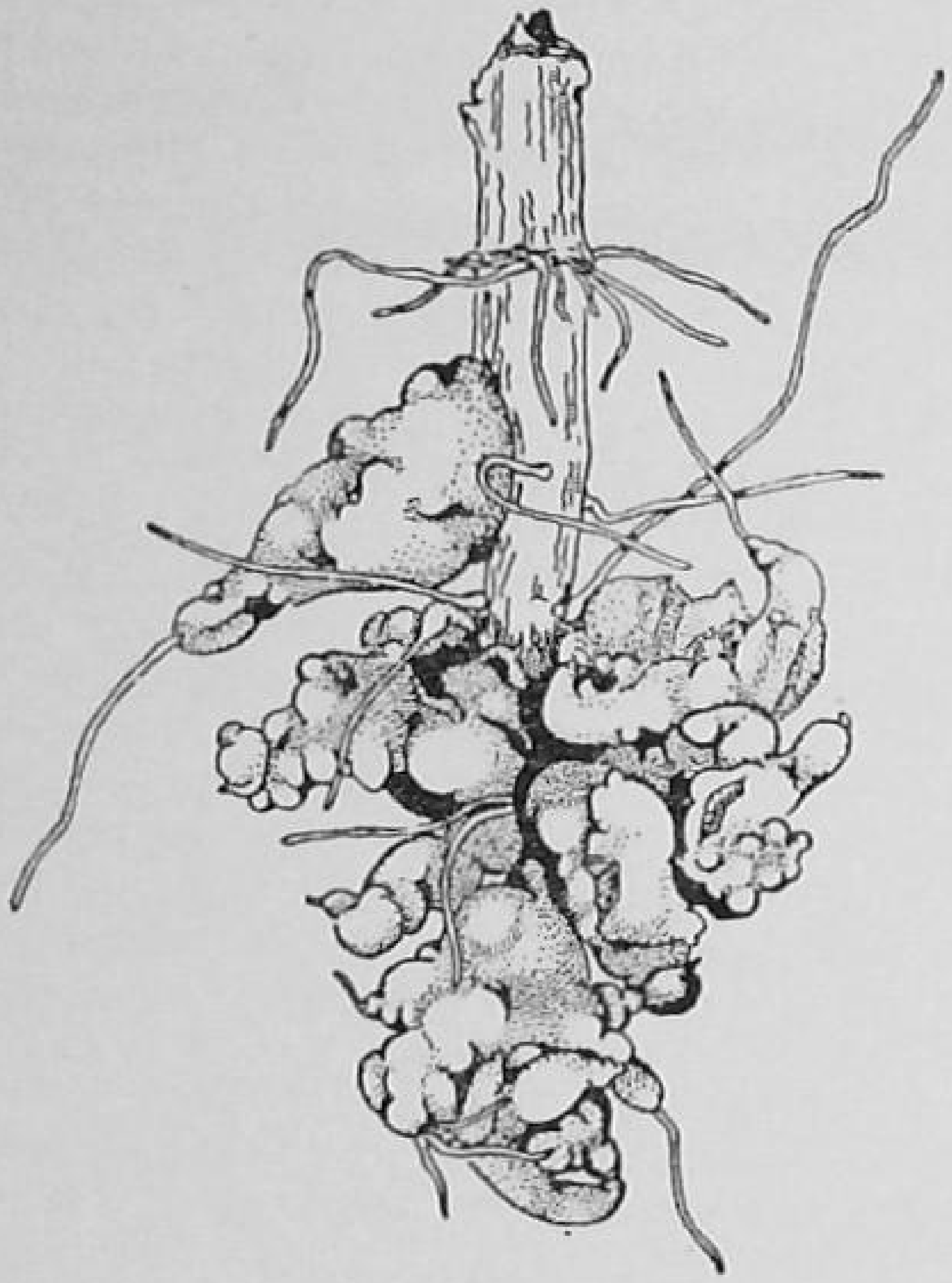

Fig. 18. Club Root.
Root of cabbage showing thickened infected rootlets together with a few which are uninfected.

infected plant become swollen, sometimes to the extent of giving them the appearance of a baby's fingers or toes (Fig. 18).

Swelling is the reaction of the tissue to the entrance of *Plasmodiophora brassicae*. Unlike most disease-causing fungi, *P. brassicae* has no mycelium. In winter months, when soil temperatures are low, it is present in the soil as small, round spores. In spring, rising temperatures stimulate the spores to burst and to free their jelly-like contents. The content of each spore is then a separate, living, shapeless unit of the fungus. It is capable of moving in the film of moisture between soil particles and is attracted to the roots of the plants just mentioned. It readily enters these. The presence of the fungus inside the root stimulates the cells of the tissue to multiply in number and to increase in size. Each jelly-like unit of fungus enlarges and some units divide to form other individuals until many of the cells of the root are filled. Finally the jelly-like content of each enlarged cell divides up into a great number of spherical spores, each having a tough envelope or wall. The tissue of the root decays and the spores are released into the soil to await suitable conditions to germinate and so renew the cycle.

Wilting of the leaves during the warm part of the day is usually the first evidence that the roots have been attacked. The leaves may recover turgidity during the night. When the roots have been so severely attacked that wilting occurs, death of the plant is almost a certainty, for although new roots may be thrown out they are very likely to be attacked in their turn.

P. brassicae is active only in soils with a certain degree of acidity and is harmless where the content of lime is sufficiently high. The action of lime is to prevent the germination of spores rather than to kill them. On infected soils, the disease may be avoided by building up the lime content to a point where the fungus becomes inactive and this treatment is generally recommended. But a note of warning is here necessary: on certain soils the amount of lime required to avoid Club Root may disturb nutritional balance. It is now well recognized that a number of elements such as iron, manganese and boron, which are essential to the health of the plant, are " locked up " in some types of soil when the lime content is above a certain level. Before embarking on a programme of heavy liming, therefore, it is well to seek the advice of a competent authority who can arrange for the soil to be tested.

Where the lime content of a soil has not been built up, or on soils where it is inadvisable to apply lime, the roots may be protected from serious attack by surrounding them with a zone of some substance which is toxic to the fungus but not to the plant. Two such substances are mercuric chloride (corrosive sublimate) and mercurous chloride (calomel). As the first is exceeding poisonous to human beings and animals, Calomel is to be preferred. It is most conveniently applied to young plants at the time of planting out. A paste is made of 4 per cent calomel powder (as purchased from horticultural chemists or sundriesmen) and water in a wooden or earthenware vessel, 3 lb. of powder to 1 pint of water. The roots of plants taken from the seed bed are dipped in the paste and set out directly in the field.

A most important point which is likely to be overlooked is that the seedlings themselves must be free from infection. If the fungus is already present in the roots, external dressings of a fungicide will be of little use. Dusting the seed-bed with Calomel powder before sowing has been found to give some protection, but it is far

safer for the seedlings to have been raised on ground known to be free of the fungus.

The above treatment does not, of course, lend itself to crops such as swedes and turnips, which are normally sown directly in the field. A few varieties of swedes, including the Danish *Wilhelmsburger* and of turnips, including, *The Bruce*, and *The Wallace* show a natural resistance to Club Root; if these varieties are used it is important to ensure that the seed purchased is of a reliable strain.

Broccoli Virus Mosaic.

Not only is good management required to ensure a succession of broccoli (cauliflowers) for spring markets, but also a certain amount of good luck. The grower must know the correct times of sowing and the strains most suited to his locality. Given these, it is still likely that unsatisfactory weather and cultural conditions will reduce the number of curds of marketable size. Yet another cause of small-sized curds is virus Mosaic; this disease is very common but not always recognized. Infected plants show " vein clearing "—that is, the veins become translucent —and a band, dark green in colour forms on each side of the vein. The remainder of the leaf blade becomes very light green (chlorotic). Spots of light brown dead tissues are sometimes distributed over the leaf blade, particularly on the underside. During frosty weather, the older leaves of an infected plant fall to the ground more readily than those of healthy plants. At the same time there is a tendency for the younger leaves to curve outwards and expose the curds to weather damage. The plants become stunted and may either produce no curds or those that do develop may attain a size no larger than that of a billiard ball. The earlier the infection the more severe the stunting.

In the field the virus is spread from diseased to healthy plants by the Mealy Cabbage Aphis *Brevicoryne brassicae* and also possibly by *Myzus persicae*, the Peach Aphis. The means by which the virus is perpetuated between successive crops of broccoli is not always clear. Where late varieties are not harvested until March or April, the next season's seedlings are already growing and could form the link. In other cases the virus may be present in those aphides which hibernate through the winter or transfer to other host plants. Thus cabbages, kale, cauliflowers, swedes and Brussels sprouts, together with the weed charlock are susceptible; with these, as a rule, the symptoms of the disease are far less marked than on broccoli and may be represented only by an insignificant mottle.

Seed bed infection seems to be of the greatest importance in many severe outbreaks. Not only is there a risk that some of the seedlings taken for planting are already infected, but the custom of having the seed bed adjoining the main crop provides a source of the virus in the surplus seedlings.

Observations have shown that infection is particularly severe in seedling beds situated near a hedge—a very common position. The reason for this association has not yet been discovered but it is probably connected with the habits of the aphis vectors. Whatever the reason, it is clear that seedling beds of broccoli should be in a plot remote from hedges and from the field in which they are to be transplanted. Another precaution is to inspect the crop in the field from time to time, beginning as early as possible, and to remove and burn those plants showing symptoms. This operation is most difficult in the warmest months of the summer because the mottle is less definite during the prevalence of high temperatures, although the virus will still be present and will show the symptoms more severely during autumn.

Downy Mildew of Onion.

Downy Mildew is one of the main reasons why onions are not a popular crop among the market gardeners of many districts of the British Isles. In normal times the bulk of our supplies is imported from sunnier and drier lands, but during the war when these imports ceased there was a necessary increase in the acreage at home. It was then that the devastating effects of the disease were emphasized. Seed crops as well as bulb crops were frequently ruined. The distribution of Downy Mildew provides a good illustration of the influence which locality can exert on a fungus disease. Its occurrence has been sufficiently regular and severe in parts of Sussex and Kent to induce many farmers to abandon onion growing and in some years it has caused considerable loss of crops in Lincolnshire and East Anglia. On the other hand it is seldom troublesome in Bedfordshire or Worcestershire, counties which have long been noted for the growing of bulb onions and for the production of seed.

The mildew (*Peronspora destructor*) is rarely prominent until July or August when it is visible as a grey or purplish downy growth on the surface of infected leaves. This growth consists of fungus threads (conidiophores), each thread being branched somewhat like a tree. Spores (conidia) are produced at the tips of the branches. The spore-bearing threads arise from mycelium which has spread within the tissue of the leaf. An infected leaf turns yellow and finally shrivels. When leaves have been killed, development of the bulb ceases and this results in immaturity and loss of weight.

Spread of the disease from plant to plant is brought about by the spores (conidia) which are so freely produced on the surface of the leaf in summer. These spores have a very short life and cannot live between the harvesting of one crop and the time when conditions are suitable for

infection of the next. Another type of spore (oospore) is formed for this purpose, but instead of being produced on the surface of the leaf it is developed within the leaf tissues. Oospores are capable of remaining dormant for many years so that when pieces of leaves from a diseased crop become buried in the soil, it is likely that any onion crop grown on that field for the next decade will be exposed to the risk of infection by Downy Mildew.

From the leaf, the fungus sometimes grows down into the bulb in which it may remain dormant and show no outward sign of its presence or it may cause shrinkage and rotting. If an infected bulb is planted for seed production, the mycelium grows up into newly formed leaves and seedstalk to produce spores on the surface, so starting an early epidemic.

Thus, there are at least three ways in which Onion Downy Mildew may begin afresh each year on spring-sown crops:—

1. From resistant spores left in the soil from a previous crop;
2. From an autumn-sown crop which has become infected in the seedling stage and has carried the fungus during the winter;
3. From infected bulbs planted for seed production.

When it is remembered that a single spore may start an epidemic, it will be appreciated that the chances of growing disease-free onions are remote in areas where conditions are favourable for spread. We have seen that with Potato Blight and certain other diseases which are spread by air-borne spores, leaves could be protected from infection by spraying with a suitable fungicide and despite the fact that both host and parasite are different, similarity in method of attack has encouraged attempts to control Onion Downy Mildew by spraying. Trials with various spray fluids have been carried out in this country and in the U.S.A., but none has so far proved successful. It is true that onion leaves are difficult to wet with a spray because they are cylindrical and upright and also have a " waxy " surface so that fluids easily run off. Under experimental conditions, however, good leaf coverage has been attained and still the results have not been favourable.

Notwithstanding the failure to prevent spread by direct methods, consideration of the ways in which the disease is likely to start on spring-sown onions indicate that the risk of early attack may be reduced by observing the following injunctions:—

1. For as many years as possible, soil which has borne a crop of mildewed onions should not be again used for that crop.
2. Spring sown onions should be grown as far away as possible from crops of autumn sown onions.
3. Bulbs for seed production should be selected from healthy crops only.

Neck Rot and Bulb Rot of Onion.

While a great deal of attention has been given to the diseases of growing onions, much less has been paid to loss of the bulbs in store. The general attitude has been that they just " rot." The total proportion thrown away could not be assessed with any accuracy, but if the numbers discarded by the housewife as well as by farmers and merchants were taken into account, the figure would be surprisingly high and losses would probably exceed those caused by more spectacular diseases in the field.

The usual agent of rotting is *Botrytis allii*, but other species of *Botrytis* are also recorded as pathogenic. The name Neck Rot has been adapted for this particular type of damage because the neck is most commonly the part to rot first. But any other part of the bulb, including the basal plate from which the roots arise, may be the first to be infected.

In wet autumns, rotting may be evident just after lifting or even some time before, but most of the damage is done during the storage period. A grey furry growth, typical of *Botrytis* will probably appear on the surface of the soft infected part of a bulb. This growth comprises a forest of fungal threads (conidiophores), each thread bearing heads of spores (Fig. 2A). Small black bodies of compacted mycelial tissue (scelerotia) may also develop on the surface of the scales.

The main factor which predisposes onions to Neck Rot is a wet sunless period in late summer and early autumn which prevents the proper ripening of the bulbs. If the leaves do not dry rapidly enough the moist and moribund tissue provides a medium on which *Botrytis* thrives and from this the fungus can grow downwards into the neck itself. In some seasons, too, rain following a long, dry spell will cause cracking of the scales and of the basal plate, permitting direct entry of the fungus to the wounded tissue.

Even if the fungus has entered the dead leaf bases attached to the neck, its entrance into the fleshy bulb may yet be checked by adequate drying, followed by storage in a cool, dry atmosphere. Onions are ready for pulling when the leaves begin to fall over and when the roots have shrivelled. They should be exposed to the sun and turned at intervals. Delay in harvesting is likely to increase liability to attack.

Damp storage conditions favour the fungus and free circulation of air between the bulbs is therefore desirable. For this reason storage in sacks or barrels is not recommended. Small numbers of bulbs may be strung into skeins and suspended from the rafters, but larger numbers are better arranged in shallow layers on trays or shelves in a building with ample ventilation.

Virus Disease of Shallot.

Shallots are not commonly grown on a large

commercial scale, but they are to be found in nearly every vegetable garden and allotment and the total annual crop must be large. They are frequently regarded as a standby for those years when onions fail to yield well or when they rot in store. It is true that shallots are easy to grow and store well, being more resistant to attack by fungi.

The great drawback has been that unlike the onion crop, the shallot is normally propagated vegetatively; that is, by the division of bulbs, instead of by seed. Further it is not uncommon for a stock of shallots to be so propagated from year to year in the same district for very many years. In view of the method of propagation adopted, it should cause the reader little surprise to learn that there are few collections in the south of the country, at least, which are not highly infected by virus. Had the virus killed the plants outright or had it produced glaring symptoms of disease, its presence would have been realized. The normal symptoms, however, are seen only in spring and are manifest as yellowish stripes at the base of the leaf. The leaves die early and the yield of bulbs is correspondingly reduced. The contrast between healthy and diseased plants is well seen if plots of each are grown near to one another and the relative yield of bulbs would also help to convince the most stubborn doubter. As it is, few growers realize that they have been growing diseased bulbs for many years and regard the early shrivelling of leaves as early maturity. To make matters worse, it has been a common practice to save the smallest bulbs of a crop for " growing on " the next year and this has helped to increase the proportion of diseased bulbs.

Little investigational work has been done to discover the status of the virus or viruses involved and what relation exists between the shallot disease and a similar disease of onions. It is, at any rate, known that the viruses are carried from plant to plant by aphides.

Significant loss of yield from virus disease may be avoided by obtaining fresh healthy stocks every few years. The frequency with which a renewal of stock is necessary will depend on the rate on infection in the area. At present there is no certification scheme for shallots but it is not improbable that stocks raised in districts which are noted for the production of " seed " potatoes might also produce healthy shallot sets.

Pre-Emergence Damping-off of Peas.

Early peas are in demand not only for marketing in the pods, but also by canners of freshly grown peas who endeavour to extend the season so as to keep their machinery in use for as long as possible. To satisfy this demand, a considerable acreage of peas is sown in late February and early March, but until recently the practice of early sowing had been regarded as particularly hazardous on account of the partial or total failure of the young shoots to appear above ground in some years. If the soil is wet and cold shortly after sowing, the seed will swell but, instead of producing an above-ground shoot, will lie dormant for a short period, and rot. The rotting may be caused by several fungi which are normally harmless inhabitants of the soil but which are capable of attacking swollen and inactive pea seeds. The remedy is to coat the seeds before sowing with a fungicide which will protect them during this period of inactivity. Dusts containing mercury in certain complex forms (organo-mercury compounds) have proved satisfactory; so has a copper oxide (cuprous oxide). The powder and seed are shaken together in a suitable container. For treating small quantities it is possible to adapt and mount a barrel to revolve in a frame and this method has been adopted on some farms. Larger quantities require more elaborate machinery and many seeds merchants have power driven machines to carry out the operation. The small extra charge which is made for dressed seed may be regarded as a low premium to pay for such a worthwhile insurance.

After mid-March, soil temperatures are, as a rule, high enough to stimulate pea seeds into a growth sufficiently rapid to avoid Pre-emergence Damping Off and treatment of the seed is then unnecessary.

Chocolate Spot of Field and Broad Beans.

In its mildest form, the disease is seen as small chocolate-coloured spots on the leaves and stem (Fig. 19). Each spot is the result of penetration by the germ-tube of a spore of one or more species of the fungus *Botrytis* (Fig. 2A). The tissue in the vicinity of the point of entry has been killed and discoloured but the fungus has not continued to spread within the leaf as happens, for instance, with the Blight fungus in potato foliage. This mild form of the disease is very common and because the damage done is limited, it has been called " non-aggressive." If conditions favourable to the fungus are prolonged, penetration and death of more tissue may occur, blackening or killing part or the whole of the stem and its leaves. This is the " agressive " form which may ruin a promising crop.

Botrytis is one of the most widespread and abundant fungi in nature. It thrives and sporulates freely on dead vegetation such as old leaves. In spring and autumn particularly, the air contains masses of spores. Some of these come to rest on bean leaves; in the presence of moisture they germinate. Weather conditions most favourable for a severe attack include sufficient rain to form and maintain for some days a film of water on the surface of the leaf, high atmospheric humidity with absence of drying sun and wind, and an air temperature of

about 20°C. Spores can remain alive on a leaf for more than a month awaiting the opportunity to germinate.

Young winter-sown plants sometimes show spotting in December but " agressive " attacks rarely occur until April or later. Since weather is a limiting factor, as is to be expected, intensity of attack varies considerably from year to year and

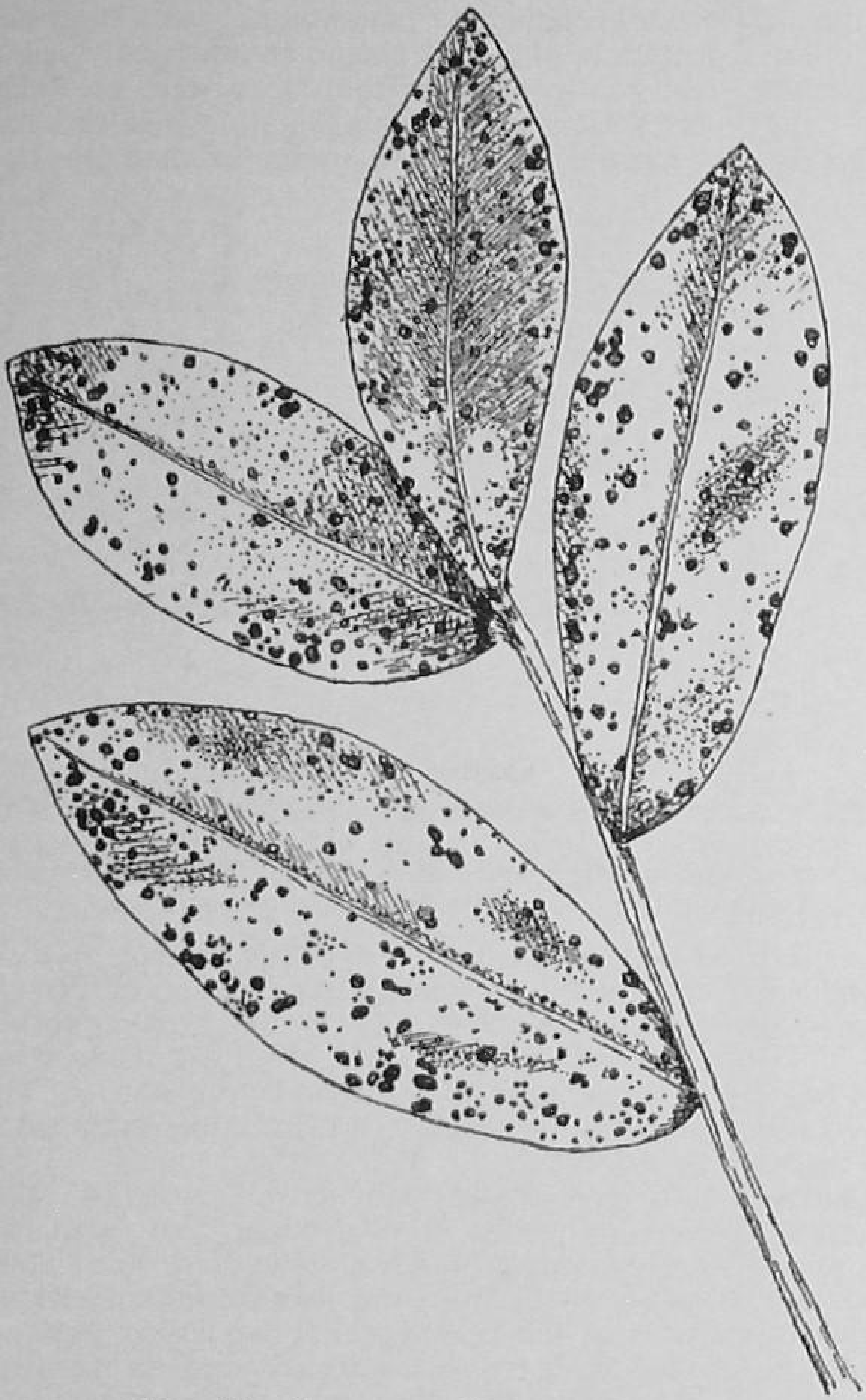

FIG. 19. CHOCOLATE SPOT OF FIELD BEANS.

Each chocolate-coloured spot on the leaflet has been produced by a germinating spore of the fungus *Botrytis*. Generally, the fungus dies shortly after having produced the spot.

the disease visits some parts of the country more than others. One of the worst years was 1935 when it was epidemic in most parts and in 1941 when it was prevalent in the North-west and very severe in the South and South-west.

The relation between growing conditions and the proneness of a plant to infectious diseases is discussed elsewhere, but there is no doubt that the nutritional status of a bean plant influences its liability to Chocolate Spot. This has often been demonstrated in severely infected crops in which one or more groups of plants have been comparatively free from spotting. As a rule, such groups are also more vigorous in growth than the surrounding plants and examination of the soil is likely to reveal that they are better supplied with potash or phosphates or that the soil is in better physical condition. Experiments have also shown that properly balanced manuring reduces the damage done by the disease. In other words, there is good evidence that attention to cultural conditions provides the best safeguard.

Chocolate Spot of beans can undoubtedly cause great loss, but the sight of an affected crop is so depressing that it has often prompted a farmer to plough it in when there was a prospect of good recovery. If an attack does not occur too late in the spring, a spell of drying weather will often check the disease and stimulate a new growth of thoroughly blackened plants.

A poor yield of beans has often been wrongly attributed to Chocolate Spot. In some parts of the country, at least, premature drop of blossoms and failure of pods to grow out is of almost annual occurrence so that the final average number of filled pods on each stem is perhaps no more than two. This phenomenon has been observed to occur as frequently in the absence of Chocolate Spot as in its presence, but the cause is as yet unknown.

From what has been said, it follows that a great deal can be done to avoid the worst effects of Chocolate Spot by paying attention to cultural conditions including the ever important detail of balanced manuring. It is likely that too close planting favours the disease by preventing the free circulation of air between individual plants and by robbing the closely packed roots of adequate nourishment. Whether or not a deposit of spray fluid on bean foliage would prevent the *Botrytis* spores from germinating is of little importance, because at the stage of growth at which most damage is likely to occur it would not be practicable to draw a spraying machine through the crop.

LEAF SPOT OF CELERY.

Leaf Spot of Celery is common alike on farm and in garden. It is also preventable with little effort on the part of the seed grower. Yet one or other of the two fungi which cause the disease have, in recent years, been found present on nearly 90 per cent of the samples examined at the

Official Seed Testing Station and nearly half the samples of celery seed examined for export have been rejected on account of it.

Infection of the plant may occur at any stage; most likely a few plants will be infected in the seed bed from seed carrying the fungus and the disease will spread from these to the remainder when planted out (Fig. 20). In the field the older leaves are the first to be seen spotted. Small black bodies, the pycnidia of the fungus, appear as a rash on discoloured areas. The spots are either lighter or darker green than the surrounding tissue; the pycnidia are numerous when infected by *Septoria apii-graveolentis*, and larger in size and brown in colour with few pycnidia when *S. apii* is involved. The former is more common and more injurious to the plant. Infected leaves may wither and rot, causing a severe check in growth and producing an unsightly plant.

Black Pycnidia can also be seen embedded in the surface of an infected celery seed and as the seed coat is frequently lifted above the ground on top of the first pair of leaves (Fig. 20), a damp atmosphere only is needed to stimulate extrusion of the spores in large numbers.

Repeated demonstrations have shown that the adequate spraying of plants with home-made Bordeaux mixture will not only reduce leaf infection but will result in an increased yield of seed free from the leaf-spot fungi or harbouring it only in negligible quantities.

Spraying with Bordeaux mixture should begin shortly after the seedlings appear in the seed bed and two more sprayings should be given before planting out; if Leaf Spot is seen after planting out, fortnightly applications should be given but should cease if frosts are expected because plants become particularly liable to freezing injury. When frosts are over and growth again begins, say in April or May, spraying should be recommenced and continued at fortnightly intervals until harvest time. In a recent small-scale trial the cost of spraying a plot which yielded 36 lb. of seed was about £5. This quantity of seed was sufficient to sow 300 acres so that the cost worked out at about 4d. per acre of crop. The seed proved to be infected only 0·5 per cent. The previous year, the seed from a nearby unsprayed plot had been infected to the extent of 84 per cent.

While spraying is the main protective measure, other precautions should not be forgotten. Rotation, of course, should be practised. Nearby celery crops, unless from clean seed, are themselves capable of spreading infection and seed crops are best grown in an isolated position.

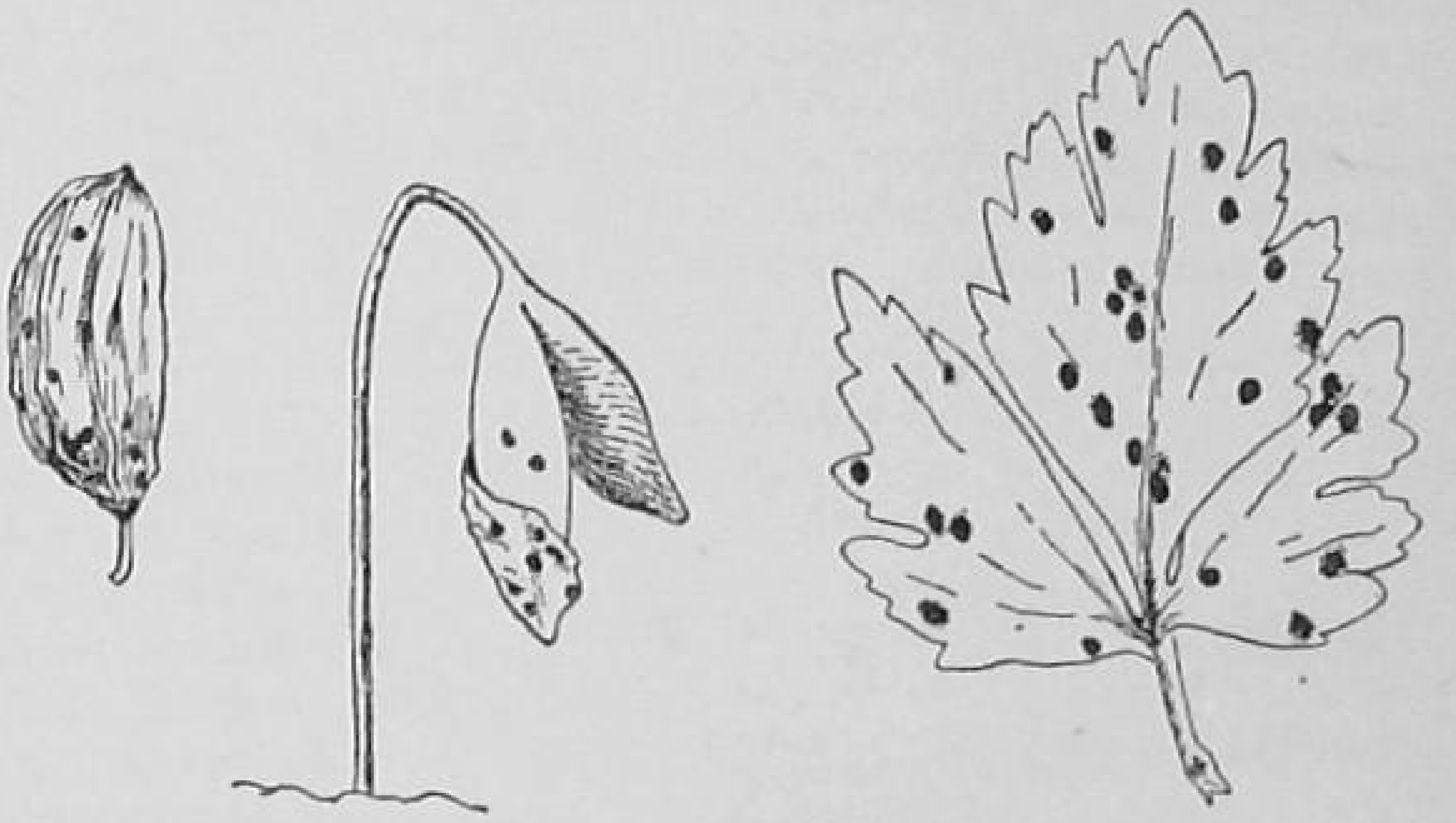

FIG. 20. CELERY LEAF SPOT.

Left: Seed with clusters of spore-producing bodies (pycnidia) of the fungus on the surface. *Centre:* Seedling with infected seed-coat still attached to cotyledon. One seed-leaf is also infected. *Right:* Celery leaf with clusters of pycnidia distributed over surface.

Another measure is to treat parent seed by soaking for three hours in a solution of formalin (1 part formalin to 300 water); a high proportion of the spores will then be killed and the seed will be undamaged if it is dried before storing. This measure is unnecessary if infection is known to be slight.

If growers of commercial crops of celery were to persist in demanding clean seed, the supply would surely follow and this would relieve them from the losses due to leaf spot. As it is, the celery grower would be well advised to steep his infected seed in formalin and keep the Bordeaux spray going until risk of marking the stalks makes the operation impossible.

FUNGICIDES

Lime.

There is a tradition of long standing in certain country circles that lime is the elixir of plant life. It is applied to the soil, not only to reduce acidity, but also with the intention of killing or rendering harmless plant-disease organisms. It has been used to whitewash the trunks of fruit trees as a general sanitary measure and is often applied to the interior of glasshouses and mushroom houses as a disinfectant.

In certain circumstances lime is useful as a combatant against plant diseases but its whiteness and the " clean " finish it gives belie its value as a disinfectant. Furthermore, it is important to distinguish between the three forms of lime which are commonly marketed. These are:—

1. Quicklime (calcium oxide—CaO), which is made by heating chalk or limestone.
2. Hydrated lime or slaked lime (calcium hydroxide—$Ca(OH)_2$), which is prepared by applying water to quicklime.
3. Chalk or other limestone (calcium carbonate—$CaCO_3$); which is quarried and sold nowadays in a finely ground condition.

Of these forms only quicklime is a disinfectant in the usual sense and this is on account of its caustic nature. As soon as it has been " slaked " with water its caustic properties are lost. But even quicklime is now outmoded and for use in disease control there is not likely to be any occasion on which one of the other two forms cannot profitably be substituted for it. Quicklime was at one time used for mixing with bluestone (copper sulphate) to make Bordeaux mixture and it was also applied to the soil for control of Club Root of Brassicas. During the last twenty years, however, hydrated lime has been marketed in the form of a fine powder in non-returnable paper bags and is generally considered more convenient. Where either of these forms is specified, they should be used only when fresh, because on exposure to the atmosphere carbon dioxide gas is taken up and conversion to calcium carbonate takes place.

Finely ground chalk or limestone is a satisfactory form of calcium to apply to the soil periodically to correct acidity.

Copper-Containing Fungicides.

Of the more complex fungicides, Bordeaux mixture has pride of place. Its discovery goes back at least to the middle of the last century, and even before that it had been found that spores of the Bunt fungus were killed when wheat grain was steeped in a solution of bluestone (copper sulphate) and that lime sprinkled on the treated seed reduced the amount of injury caused by the bluestone alone.

There is no agreement as to the best proportions in which the ingredients of Bordeaux mixture should be mixed but nearly all recipes allow for a quantity of lime in excess of that required to produce a neutral reaction, and except where the plant has to be sprayed is unduly liable to injury by lime there is perhaps not a great deal to choose between them.

A formula which has proved suitable for most spray programmes is:—

4 lb. blustone ($CuSO_4.5H_2O$)
5lb. hydrated lime.
40 gal. water,

or in small quantities for use in gardens and allotments,

4 oz. bluestone
5 oz. hydrated lime.
2½ gal. water.

In spite of the fact that Bordeaux mixture is a solution of two simple inorganic substances, the reactions on mixing are far from simple and are not even now fully understood. There are several different ways of mixing it, but whichever is adopted, the resultant fluid should be used within twenty-four hours.

The following is one method of making up 40 gallons:—

Dissolve 4 lb. of bluestone in 4 gal. of water (hot water is quicker) in a wooden or earthenware vessel. Pour 36 gal. of water into the mixing tank, sprinkle in 5 lb. of hydrated lime and stir. While still stirring mix in the 4 gal. of bluestone solution and the mixture is ready for use.

Bordeaux mixture, contrary to popular belief, does not corrode galvanized or iron vessels. A solution of bluestone alone, on the other hand, does cause corrosion, so that if mixing is to be done in a metal tank, a suspension of hydrated lime should first be made (as described above) and the bluestone solution poured into it, taking care that the stream does not touch the sides.

Before the days when finely powdered hydrated lime was easily obtainable Burgundy mixture (sometimes called soda Bordeaux) became popular in those districts where quicklime was not made. This is prepared in a manner similar to that for Bordeaux mixture, but washing soda crystals (sodium carbonate) are used instead of lime, the recipe being:—

4 lb. bluestone
5 lb. washing soda
40 gal. water.

Burgundy mixture is nearly as effective as Bordeaux mixture but is more likely to scorch foliage.

As a copper-containing fungicide, it is doubtful whether Bordeaux mixture has been surpassed. This is not to say that other preparations are less

toxic to fungi; rather the deposit left by Bordeaux mixture is such that it "reacts" with the weather to protect the leaf. Particularly does it adhere firmly to the foliage and it is not readily washed off by rain. Following rain or dew the copper held in the deposit is slowly brought into solution by the film of water which covers the leaf-surface, and the concentration is sufficient to kill spores of many of the disease-causing fungi which normally germinate under such moist conditions.

The effort required for the preparation of Bordeaux mixture is often put forward by growers as one of the reasons for preferring certain other copper fungicides which are ready for use on stirring with the required quantity of water. Also, certain other preparations cause less wear to pumping machinery. A modification of ordinary Bordeaux mixture, which was rapidly being adopted by growers of fruit and hops just before the war, was the addition of edible cotton-seed oil to half-strength Bordeaux mixture. This proved to be easier to pump and to have the added advantage of controlling Hop Mould. It also provided a suitable vehicle for nicotine. A single fluid thus served as an insecticide as well as a double fungicide.

Compounds for spraying foliage which have found favour amongst farmers in recent years include copper oxide and copper oxychloride. The organic compounds, copper sebacate, copper phthalate and cupric cuprimalate have been proved outstanding fungicides on an experimental scale but for one reason or another they have not yet been prepared in a form satisfactory for commercial use. One of the main difficulties seems to be poor adhesion to the leaf.

Experience has shown that copper fungicides are more efficient applied to foliage as sprays than as dusts. On the other hand, the application of a dust is easier and cheaper and a supply of water is not required. For this reason, preparations corresponding to the popular wet sprays are in common use as dusts. Thus, "copper lime" dusts and "Bordeaux powders" are popular among smallholders. In addition to having less fungicidal value, these have the disadvantage that a heavy shower shortly after application will wash off the particles. It is usually necessary to apply dusts more frequently than sprays.

A fungicide which is much used by nurserymen as a soil disinfectant is Cheshunt Compound. This is made up of 2 parts of bluestone and 11 parts of carbonate of ammonia. These compounds are crushed, mixed together and left in an airtight jar for at least 24 hours before use. A solution made up of 1 oz. of the mixture to 2 gal. of water is the nurseryman's standby for checking the spread of *Phytophthora* Damping Off of tomatoes. When watered into the soil, the fungus is killed but the plant is uninjured unless the fungicide is used to excess.

SULPHUR-CONTAINING FUNGICIDES.

The main use of copper fungicides is to provide a protective coating of copper over the surface of the plant; they are especially effective against spores of fungi of the "downy mildew" types, such as Blight of Potatoes. Another large group of fungi is known collectively as the "powdery mildews"; in these the mycelium grows over the surface of the plant, feeding on the outer layer of cells, and does not penetrate deeply. Many of the powdery mildews can be controlled by the application of sulphur or sulphur-containing compounds to which the superficial mycelium is very sensitive.

For well over a century, "flowers of sulphur" has been in use as a fungicidal dust and is still popular for the control of the powdery mildews of gooseberries, vines, strawberries and hops. Flowers of sulphur is elemental sulphur brought into a finely divided condition by sublimation. During the last two decades, processes have been evolved to grind rock sulphur into particles sufficiently fine to act as a substitute.

Particles of sulphur cannot be moistened with water, but if a "wetter" such as soap be added, finely divided sulphur in suspension can be used as a spray. In this form its fungicidal effect is equal to or better than that of the dust. Finely particulate sulphur in suspension is known under the names of "wettable sulphur" and "colloidal sulphur."

Perhaps the most widely used sulphur-containing spray fluid is lime-sulphur. In the early part of this century it was made on the farm by boiling a suspension of hydrated lime (milk of lime) with sulphur, but stronger and more standardized solutions are now made commercially and can be bought in a concentrated form needing only dilution with water before use.

Sulphur in the form of a gas or vapour is also used for fumigating glasshouses, mushroom houses and other buildings. When no plants are present, the potent fungicidal (and insecticidal) gas, sulphur dioxide, may be used; this is evolved by burning rock sulphur. Less potent, but still an effective fungicide, is sulphur vapour, produced when rock sulphur is brought to a temperature just high enough to be volatilized but not ignited. This method is popular for the control of powdery mildew of the vine.

MERCURY.

Mercury has been in use as a preservative against moulds for very many years, but its use as a fungicide in farming practice has been limited by its poisonous properties to human beings. The well-known compounds mercuric chloride (corrosive sublimate) and mercurous chloride (calomel) have both proved their value as fungicides when applied to soil infected by the

Club Root fungus, but one of the greatest advances in plant therapeutics is the use of "organo-mercury" dusts for disinfecting the seed of cereals and other plants before sowing. Also, during the last decade, much experimental work has been done to test the effectiveness of mercurial compounds as spray fluids and some of the more promising are already on the market under trade names.

Other Fungicides.

Fungicides containing copper, sulphur and mercury are the main ones in present use, but research is constantly testing new compounds, many of them with complex chemical structure. A few of these have proved of great value in the prevention of specific diseases. Pentachloronitrobenzene, for instance, has been successfully used for some years in the prevention of *Botrytis* disease of lettuce. It has the advantage of being non-poisonous. As another example, the comparative freedom from disease of the large acreage of flax which was grown during the 1939–45 war was undoubtedly due to the dressing of the seed with tetramethylthiuramdisulphide.

Plant Injury.

There are probably no fungicidal substances which are not liable to cause a certain amount of damage to the plants on which they are used. It is often a question of concentration of the chemical. Thus, at high concentrations, lime sulphur, when used in the control of Apple Scab, may cause injury; at lower concentrations (say 2 per cent) it is safe to apply to the leaves of most apple varieties, but will still severely injure the foliage of others. But when petals have fallen (with all varieties) the concentration must be reduced to, say 1 per cent, or the young fruitlets will be injured.

Damage to plants by fungicides, insecticides, hormones and other substances, applied with the intention of benefiting them is the nightmare of the Advisory Plant Pathologist. Such damage may result in unfamiliar symptoms and much time is spent in searching for organisms likely to have been responsible. The endless flow of new anodynes keeps the problem constantly alive. Whether or not damage will occur often depends upon local conditions at the time of application. A plant in vigorous health may withstand treatment which would kill or seriously injure one which is weakly. Scorching of leaves may follow if spraying be done in direct sunlight. A fungicide or insecticide, itself harmless, may have been mixed with a harmful "base" or "filler."

Soil Disinfection.

When there are no plants present to be injured, very strong disinfectants are often employed to kill soil-infesting fungi in glasshouses. This is normally done between the removal of one crop and the planting of another. Raising the temperature of the soil by steam nearly to boiling point is the most efficient method. When through lack of apparatus, or for other reasons, this is not possible, saturation with 2 per cent—5 per cent formalin is a good substitute. If thoroughly carried out it will kill most plant pathogens.

Formalin.

Formalin is the name given to a 38 per cent–40 per cent aqueous solution of the gas formaldehyde, and it is sold in this form by horticultural chemists and sundriesmen. The soil to be treated is forked to the depth of one spit and the formalin (5 gal. formalin to 95 gal. water) is watered in at the rate of 2–5 gal. to the square yard. The treated areas are covered with wet sacking so that fungicidal gas, not being allowed rapidly to diffuse into the air, has an opportunity of reaching the centre of every soil particle. After 48 hours or more the sacks are removed and the heat of the house raised to encourage the vapour to escape. When there is no further smell of formaldehyde, it may be assumed that planting will be safe. This may be two weeks or more after treatment, but in any case it is a wise precaution to plant a few test plants here and there to ensure that the lethal effects have vanished.

Whether steam or a chemical is used for sterilizing, the treatment can be expected to be effective for no more than one, two or at the most three years. This is because only those fungi living in the top layers of the soil are killed and reinfection occurs from lower layers if not from other sources. Risk of reinfection has led to the development of raised cement beds which support a sufficient depth of pasteurized soil. The method is popular for avoiding the Wilt disease of carnations and might with advantage be used for many other glasshouse crops.

Small quantities of soil for potting may be completely freed from disease-causing organisms by heat or by applying 2 per cent–5 per cent formalin. To apply the formalin, the screened soil is built layer by layer into a heap. As each 6 in. layer is built, it is freely watered with the dilute formalin at the rate of about one gallon to the bushel of soil. The heap is then covered with a wet sack for about 48 hours to allow the gas to penetrate. After this the soil is spread into a thin layer until all smell of formaldehyde has departed.

On Buying Fungicides.

Many fungicides and their components deteriorate rapidly in storage and only those which are known to be fresh should be bought. It is also a good plan not to have delivered to the farm more than sufficient for current use; farm buildings are

notoriously ill-adapted for housing " chemicals " for even short periods.

Assessment of the quality of fungicides or their components is a specialist job and it is best for the grower to deal only with reputable firms who have a knowledge of the substances they are selling.

With regard to proprietary products, the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland started in 1942 a scheme for the official approval of insecticides and fungicides marketed in Great Britain under brand names. The approval relates only to conditions in Great Britain and to a period after the manufacture of a product covering at most two seasons of application. The container of an approved product bears the official mark.

Application for approval is voluntary, so that absence of a product from the list does not signify that approval of the substance has been withheld. The presence of a substance on the list gives no indication of its merits relative to other proprietary substances or to non-proprietary substances, but it helps the purchaser by ensuring a known standard of composition.

Lists of approved proprietary products are issued by the Ministry of Agriculture from time to time.

CONTROL OF PLANT DISEASES

Preliminary Considerations.

Once a disease has been introduced into a district attempts to eliminate it are rarely successful. It may be reduced to comparative unimportance by the application of appropriate measures; it may be rendered so impotent that its previous powers of destruction are forgotten until a sudden outbreak follows a slip in the scheme of control and so brings a sharp reminder that the pathogen only awaits an opportunity to bring disaster.

The word *control* is in frequent use by those who are concerned with diseases, whether of humans, animals or plants. It covers both prevention and cure. *Control measures* are the measures taken to keep a disease within reasonable bounds.

Before attempting to evolve control measures for any particular disease, it is an advantage to find out the cause of the disease; and if the cause is a living organism, to find out its life-history and its relation to the plant. With a virus it is necessary to discover the host range and the manner of spread between healthy and diseased plants. Environmental factors, including the influence of temperature and moisture, should also be investigated. It is true that on occasion one of the "hit or miss" methods has made a "hit" and a degree of control has been achieved without much detailed knowledge; but even then its efficiency will have been greatly improved by the discovery of new data and a scientific approach.

Many unexpected and strange facts have come to light following careful observation and experiment. The life histories of some of the fungi are very complex. There are, for instance, the cereal "smuts" which have many points in common and yet are sufficiently different in a few important details to enable one group to be controlled by the mere shaking of the cereal seed with a dust while the other group is practically impossible to control. With Blunt of wheat and rye, Covered Smut of barley, Loose and Covered Smut of oats, infection of the host takes place by means of spores which adhere to the exterior of the seed. When the seed germinates, the spore also germinates and the fungus penetrates the base of the young shoot (seedling infection). With Loose Smut of wheat and Loose Smut of barley the spore is airborne to the open flower on which it germinates (blossom infection). This does not prevent grain formation, but the fungus lies dormant within the seed until germination time. With both types of smut, the mycelium grows upwards in its host keeping pace with stem development, but without causing visible injury. At some time during ear formation, the fungus enters the developing grain which becomes filled with spores. These spores break out of the seed sooner (in loose smuts) or later (in covered smuts) to be distributed to blossom or to the exterior of seed. Whether the fungus parasite is carried through the winter inside or outside the seed is of considerable importance, because only in the latter case is it accessible to disinfectants.

Most fascinating of all in strangeness, perhaps, are the rusts. Members of this group have typically three kinds of spores, uredospores, teleutospores and aecidiospores with secondary spores additional. Commonly, the uredospores and teleutospores are produced on one type of plant and the aecidiospores (from an aecidium or cluster cup) on another, the *alternate hosts* being as often as not of unrelated families. Connected with the aecidia are specialized spore forms (spermatia) which have a sexual function; spermatia connected with one aecidium must fuse with spermatia from another before aecidiospores are produced. The teleutospores also produce secondary spores when they germinate. These are known as sporidia and their function is to infect the host which will later bear aecidia. Black Rust of wheat, *Puccinia graminis*, the classic example of a rust with *alternate hosts* has already been described and reference made to its diminished importance as a parasite since the campaign against barberry bushes began.

With Plum Rust *Puccinia pruni-spinosae*, the leaves of plum produce uredospores and teleutospores while a few species of *Anemone*, particularly *Anemone coronaria* act as the host for aecidiospore production. In the anemone the fungus is capable of living within the rootstock as well as on the leaves so that a single infected plant can continue year after year as an agent of infection of plum leaves. Black Currant Rust (*Cronartium ribicola*) has five-needled pines as its alternate host and the disease is particularly common in the vicinity of Weymouth pines. Curiously, in parts of U.S.A., more concern is felt over the damage done to pines than to currants and war has long been waged against bushes of wild currants in the pine forests.

On gooseberry and also on black currants are produced the aecidia of the rust, *Puccinia pringsheimiana*. For this reason and to distinguish from *C. ribicola* it is known as Cluster Cup Rust. The uredospores and teleutospores are found on a number of species of sedges and it is only in areas where these are abundant that trouble is serious. The practice of using sedges as a mulch has also caused disaster.

Many rusts have no known alternate host and survive either by means of uredospores alone or because all stages occur on the one host. Flax Rust, *Melampsora lini* is an example of the latter.

Influence of Environment on Fungus.

That climate exerts a major influence on the incidence of disease is well known. Most fungi thrive best under moist conditions, but there are exceptions such as Mildew of wheat (*Erysiphe*

graminis) which is most prominent after a mild winter and a dry spring. The different phases in the life-history of a fungus or bacterial parasite are particularly sensitive to temperature and this factor is now usually measured with some accuracy in the laboratory. Generally, four measurements are of most interest: the maximum and minimum temperatures at which the organism can pass through the phase under consideration, other conditions being favourable; the temperature most suitable to the performance of the phase and finally the temperature at which the organism is killed (thermal death point). It is necessary to know the stage or phase in the life-history because the temperature for each may be different. Thus, many forms of spores are particularly resistant to high temperatures and some even withstand boiling, while the mycelial stages may be easily killed.

At low temperatures the Club Root fungus is rendered inactive and this explains why spring cabbages often escape the disease on badly infected land while summer and autumn crops become diseased. The same fungus may be used to illustrate how the acid-alkaline balance will influence disease. If soil is slightly on the alkaline side of neutral, the spores are unable to germinate and infection cannot occur. For this reason heavy liming is usually advocated where the disease is present. On the other hand, Common Scab of potatoes and certain deficiency diseases are favoured by alkalinity so that the elimination of one disease by soil treatment may result in the development of others.

Climatic conditions greatly influence the fruiting of fungi. In the same way that mushrooms and toadstools are produced prolifically in some seasons and not in others, so parasitic species are stimulated or discouraged from fructifying. The hard, black, resistant resting bodies (sclerotia) of *Sclerotinia sclerotiorum* seem to require exposure to low temperatures before they can develop fructifications. Then there are the fruiting bodies of the Apple Scab fungus which are embedded in the overwintering leaves and which await special conditions of moisture and temperature before they ripen and eject their spores. In a few countries attempts are being made to forecast each year the time at which ejection will take place so that the spray programme may be synchronized with that stage.

Without a fairly detailed knowledge of the habits of viruses, there would be little hope of evolving rational methods of control. The *modus operandi* is in many respects quite different from that for fungi or bacteria. There are apparently no spores to be blown about and outside the host tissue the virus is rarely long-lived. Infection of soil does not play an important part in the known histories of most plant viruses. There are many other main differences. Thus, with Tobacco (Tomato) Mosaic the ease by which infection can be spread by the transfer of sap from diseased to healthy plants is outstanding. With so many other viruses, painstaking research has shown the intimate and strange association between insects, particularly aphides, and the essential part they play in the transfer from one host to the other. In this way is spread Leaf Roll and Rugose Mosaic of potatoes, diseases previously thought to be due to old age. The danger of jumping to conclusions was well illustrated when thrips were found to be the insect carriers of the virus of Tomato Spotted Wilt, for the anatomy of this insect does not conform to the specification expected of virus *vectors*.

There are still many virus diseases with little known of their histories beyond the symptoms they produce. One of the most troublesome diseases of the hop, known as Nettlehead, is attributed to a virus. Its effects are influenced by type of soil; hop plants on the sites of old hedges seem particularly prone to infection. The method of spread is unknown. Attempts to transmit the disease by sap or by any of the insects commonly found in hop gardens have so far failed. Another hop virus of unknown history causes Mosaic disease among the choice "Golding" varieties of East Kent. It is known that "Fuggle," the most commonly grown variety, can carry the virus without itself showing symptoms of disease and that the two varieties should not be grown near each other. As infection cannot be transmitted by sap, an insect vector is presumed, but the culprit has not been discovered. There is little doubt that precise information on the mode of spread would lead to a higher degree of control than is now obtained.

Methods of Control.

After a knowledge has been gained of the relations between a pathogen, its host and environmental conditions, an examination of the data may reveal weak links in the chain and point to likely methods of control for experimental and practical testing. Control measures may be classified in several ways. For present treatment they will be considered under the following headings:—

1. Control by direct attack on the pathogen, e.g. with a fungicide.
2. Control by starvation of the pathogen, e.g. by crop rotation.
3. Control by avoidance of pathogen, e.g. by the use of uninfected seed.
4. Control by increase of host resistance, e.g. by the breeding of new varieties.

1.—Control by Direct Attack on the Pathogen.

The reduction of disease by direct attack on the pathogen is often the least subtle method and its employment is usually an admission of partial defeat because it means that the host has

already become infected or is shortly expected to be attacked. There is also the risk of damage to the host by the preparations used because, in sufficient concentrations, many of them are plant poisons. But direct attack is the only known method of controlling some diseases. The use of fungicides on seeds has proved particularly effective. Treatment of cereal seeds with organo-mercury preparations to kill the spores of certain smuts has reduced these diseases within a few years from plagues to relatively insignificant isolated outbreaks. The disinfection of pea seeds is now a routine measure in districts where exceptionally early sowings are made to extend the active season of the canning factories. Before this protective practice was adopted, losses caused by soil fungi, which attacked the dormant but swollen seed was an annual hazard.

The application of fungicides to the foliage of crop plants is now well established throughout the cultivated areas of the world. Reference to control of Potato Blight has been made in some detail earlier in the book. The method acknowledges that there is always a source of infection not far from the crop and the spray schedule is timed according to local climatic conditions. It is important to realize that copper-containing sprays such as Bordeaux mixture must be applied as a protective coating to the foliage before spores of the fungus are being distributed.

As with most " downy mildews " the mycelium of *Phytophthora infestans* works within the tissue of its host and cannot be killed, except by killing the plant itself. With " powdery mildews " of the vine, the gooseberry, the rose and other hosts, the mycelium is superficial and can be easily reached with a dusting of powdered sulphur. This treatment is possible when the attack has already begun.

Leaf Spot of celery may be checked by spraying the foliage with Bordeaux mixture; there is good evidence that the disease could be reduced to unimportance if the spray were always applied to seed crops so as to prevent the fungus from reaching the inflorescences. Seed from sprayed plants is likely to be uninfected and generally produces disease-free crops.

Treatment of soil by heat or by chemical disinfectants may be regarded as a form of direct attack, for it clears the volume of soil treated from certain root-destroying organisms and from other parasites. Many nurserymen go so far as to place a concrete platform beneath a sufficient depth of soil so sterilized to act as a barrier against reinfection from the subsoil. There is a number of glasshouses in which this device is essential for the protection of carnations against *Verticillium* wilt.

Viruses do not lend themselves well to direct attack except in the destruction of debris from infected crops and in the killing of vectors containing them.

2.—Starving the Pathogen.

Mention has been made of different degrees of parasitism which exist. Thus, some fungi (obligate parasites) cannot develop or increase except when living on the host. Other fungi (facultative parasites) can draw food from non-living organic matter and only become parasites when a suitable host is within infecting distance. In between these extremes are others which seem to have the ability to live and develop a limited time without the presence of a host or to become weakly parasitic on weeds or other plants to which they do little damage.

The rusts have been cited as examples of obligate parasites and if a satisfactory break can be made in their life cycle there is a gap when the fungus has nothing on which to live and in a sense it will be starved to death. The break may be brought about by keeping alternate hosts apart (e.g. by elimination of the barberry) or by excluding a susceptible host from the vicinity of resting spores during their period of viability.

Of less extreme parasitic habit are some of the soil-inhabiting fungi such as *Ophiobolus graminis*. This causes a disease of wheat and barley but it can also live on the roots of certain grasses and has a degree of saprophytism. *Cercosporella herpotrichoides*, Eyespot of wheat, has a similar history. *Sclerotium cepivorum*, which causes White Rot of onion produces small sclerotia in the mass of mycelium which envelops the bulb. The sclerotia can remain alive in the soil for many years. With soil-inhabiting parasites, the presence of susceptible crops at short intervals causes a " build-up " in quantity, and perhaps in virulence, until severe disease is an annual certainty. If, however, the land is fallowed or if only immune crops are grown, then the quantity and virulence of the parasite is likely to become less. The parasite will have been starved out. The time required will vary according to several factors. With *O. graminis*, three or four years may be sufficient on most soils but with *Sclerotium cepivorum* more than 14 years may be required. The effects of continuous cropping were particularly evident during the second World War when the growing of successive straw crops on the same land often increased Take-All and Eyespot diseases to a danger point. Where reasonably lengthy rotation of crops were practised these soil-borne diseases were of little account.

3.—Avoiding the Pathogen.

The two methods of controlling disease which have been discussed above aim at killing the parasite by direct attack or by starvation. These measures are employed when the fungus is actually on a farm and simulate cure rather than prevention. In the same way that there is now

more emphasis on the avoidance of human disease than on its cure, so in plant medicine it is more and more realized that a little effort spent on prevention is often more effective than spending a great deal of time and money on palliative measures. When the life history of a parasite and its relation to the host is sufficiently understood, there is always a good chance that the disease can be completely avoided or greatly reduced by ensuring that the farmer or gardener does not introduce infected material to his holding.

Mention has been made of seed disinfection and with regard to certain diseases this may be regarded as a routine precautionary measure, whether the parasite is known to be present or not. If treatment has been effective, then the particular disease may be avoided altogether. But neither the machine nor its human attendant is infallible and it is much better to use seed which is known to be pathogen-free from the beginning. In other words, seed must be produced under conditions in which contamination is unlikely to occur. Rejection of diseased samples of seed is a corollary to this method and necessitates inspection of the growing crop, and perhaps also of the seed, at selected periods.

Among diseases known to be carried with seed are those of peas, caused by different species of the fungus *Ascochyta*. In the field these will cause Leaf and Pod Spot and sometimes also Foot Rot. From the pods, the fungus penetrates the seed. If, after sowing, a diseased seed does not rot in the ground, it acts as a source of infection for the remainder of the crop. As an indication of its importance, it may be said that of 1,000 samples taken from consignments intended for export in recent years, about 22 per cent were rejected on account of these diseases. Since the main method, if not the only method, of starting the diseases each year is by the seed, the significance of seed examination is clear.

Bacterial Canker (*Corynebacterium michiganense*) is a seed-borne disease of tomato which has been known in the Americas for many years. It was originally given the striking name of "Grand Rapids Disease" on account of its early association with that district of the U.S.A. Bacterial Canker was not recorded in Britain until 1942 when it occurred on outdoor plantations in Sussex and Kent. There was evidence that the disease had been introduced with seed from abroad. American experience had shown that the only way in which spread was likely to take place was by infected seed, so it was arranged that no seed should be saved on those nurseries where trouble had occurred. By that time, however, infected seedlings had been inadvertently sold in the open market and the disease seems now to have become established in Britain. Each year a few outbreaks are recorded, mainly in gardens and allotments. Its comparative absence on commercial holdings since the first records were made is probably due to the care taken by seed merchants in obtaining seed and to the cessation of imports from affected areas.

The principle of avoidance applies not only to seed proper, but also to any planting material which may be transferred from one holding or district to another. Indeed, it is with "vegetatively propagated" plant material that disease is most likely to be introduced for not only will pathogens live in the tissues of tubers, bulbs, roots and other organs of propagation, but they frequently adhere to the particles of soil which accompany them.

Transmission of diseases in parts of plants other than the seed is well illustrated by a consideration of the virus diseases of potatoes. Descriptions of Leaf Roll and Rugose Mosaic, the two most important, have been given earlier in the book. With a knowledge of the facts relating to these diseases the way to avoidance is comparatively simple. The viruses are known to be carried from diseased to healthy plants by aphides so that if the season started with healthy plants only, there could be no spread of disease. It is also known that under the climatic conditions of certain districts there is a good deal of aphis movement and hence rapid spread. In other districts, notably in Scotland and Ireland, there is relatively little movement of aphides and correspondingly little spread of the viruses. Therefore, by concentrating on "seed" production in districts of little spread and by growing potatoes for food from this clean seed in other districts, the problem can be solved. This method has been adopted in Britain, and in other countries, with signal success. For the proper working of the measure, a scheme of inspection and certification has been in operation for several years.

Virus diseases of strawberries, raspberries and blackcurrants can also cause great devastation and schemes for the production of healthy stocks are coming into increasing favour among growers.

4.—Increase of Host Resistance.

A fourth way of controlling disease is to find, if possible, varieties or strains of plants which cannot be infected or at any rate which suffer little damage if infected. Added to this is the possibility of increasing the resistance to a disease of existing varieties by manurial or other treatments.

For instance, it is well known that Wart Disease (*Synchytrium endobioticum*) can infect many varieties of potato, including the popular King Edward, and it is useless to plant these varieties on soil which is infected by the fungus. There are also varieties, including Majestic and Arran Banner, which cannot be infected by *S. endobioticum* however full of the fungus the

soil may be. The use of immune varieties in districts where the pathogen is present is the complete solution to the problem. Unfortunately there are not many instances as clear-cut as this and even where they do exist it does not follow that the immune varieties are of sufficiently good quality or that they are sufficiently resistant to other diseases. It is well established however that varieties of a crop plant which are in common use, almost invariably show marked differences among themselves of susceptibility to any particular disease. Thus, a list of wheat varieties can be arranged according to degree of susceptibility to Yellow Rust or to Black Rust; of potato varieties according to susceptibility to Blight, to Common Scab or to Leaf Roll; of apple varieties according to susceptibilities to Scab and so on. Such knowledge is widely used in farming practice and varietal preferences in a district may be largely related to local diseases.

In connexion with the reaction of a host to a pathogen, the terms "susceptibility," "immunity" and "resistance" have been freely used and with the growth of the biologic sciences, these have entered our language as almost household words. In plant pathology, particularly in relation to viruses, newly discovered facts have made previous definitions somewhat obsolete and the terms have been used variously by different authors thus causing confusion. In fact a short paper has recently been written by Ernst Gaumann (1946) to elucidate the matter. But whether or not the reader is interested in the exact definitions of the terms, it is important that there should be an understanding of the degrees of relation which can exist between pathogen and host.

Ainsworth and Bisby (1945) adopt the definition of *disease* as *a condition in which the use or structure of any part of a living organism is not normal* and of *immunity* as *the condition of having qualities which do not let, or not having qualities which let, the development of disease take place.* By these definitions a plant which "carries" a virus but shows no symptoms might be considered diseased, but from a practical viewpoint the breeding of plants which can carry a virus without showing ill effects is a valuable means of avoiding the trouble. For instance, there are new varieties of hops which carry the virus of Hop Mosaic but which show no symptoms and are therefore being planted up increasingly. *Resistance* is defined as *the power of an organism to overcome, completely or in some degree, the effect of a pathogen or other damaging factor.* From this we conclude that the "carrier" hop is completely resistant (but not immune) to the virus it carries. Another variety which dies very rapidly after infection would be said to have little or no resistance. Between these two extremes are varieties which may show symptoms but live longer and, like earlier examples, show different degrees of resistance. On account of genetical or constitutional factors it is usually varieties which have a high degree of resistance to a pathogen rather than a complete resistance which are adopted for commercial use.

In breeding work the combining of the character of disease resistance with those of other desirable characters is becoming better understood as time goes on. Among the early successes in this field was the breeding of the wheat variety "Little Joss" as one resistant to Yellow Rust (*Puccinia glumarum*).

Resistance can result from various causes. It may be due to an apparent "distaste" of the pathogen for the host or to physiological resistance of the tissues which prevents the parasite from making headway. Paradoxically it may be due to hypersensitivity of the host to a pathogen. This latter mechanism is apparently responsible for the near-immunity of some varieties of wheat, including "Einkorn" to Yellow Rust. With this, the small groups of cells attacked by the parasite is so rapidly killed that the fungus has no time to become established. Resistance of some plants to viruses is also due to hypersensitivity.

Again, freedom from infection might be the result of physical peculiarities of the host such as the possession of an unusually thick cuticle on the epidermal layer of cells which would prevent penetration of the germ-tube of the spore of an invading fungus. A virus-carrying aphis might be baffled for the same reason.

In spite of rosy prospects, the breeding of new varieties as a means of disease control is not the easy road it might seem. It has been found that in many cases the resistance of the plant breaks down after a time or, what is perhaps more likely, a form of the parasite comes into prominence which is capable of overcoming resistance. In regard to this it must be realized that as there are varieties and strains within a species of flowering plant, so there are different forms within each species of fungus and type of virus. Leaf Mould of tomato (*Cladosporium fulvum*) and the variety Vetomold provide an example.

Vetomold (a hybrid between Potentate and the Red Currant Tomato) was bred in Canada and appeared to be immune to *C. fulvum*. The variety was tried in Britain and for a year or so withstood attacks by the pathogen. Then, gradually, records of infection began to accumulate. Investigation indicated that there were at least four distinct forms of *C. fulvum* and that Vetomold was immune to two of them. It must be supposed that none of these forms pathogenic to Vetomold was very active in Britain, but with lack of competition from other forms, they were able to establish themselves and increase in quantity.

Instances of the influence of nutrition on the resistance of plants to disease are very numerous. Indeed, there are very few diseases which do not react to changes in the nutritional status of the

host. The reason for this is not always clear, but in some cases there are likely explanations. Thus, as a counter measure to root-rotting organisms it is often an advantage to apply manures which will encourage the plant to put out new roots to replace those which have been destroyed. In this way, phosphatic manures tend to reduce the amount of damage done to wheat by *Ophiobolus graminis*.

Applications of excessive amounts of nitrogenous manures encourage a luxuriant growth of foliage and where this exists a soft type of leaf results; many fungi seem to thrive best under such conditions. Liberal applications of potash, on the other hand, seem to render the plant more resistant to attack. Some viruses, too, are sensitive to the condition of the plant, as has been shown with Mosaic disease of tomato. Here, not only is resistance to systemic infection altered, but there is also evidence that nutritional differences will govern the direction of movement of the virus once it is within the plant.

Salient Points in Control.

After considering a number of the factors relating to the control of plant diseases, some salient points might be expected to emerge. To begin with, it is quite clear that the local intensity and even the existence of any particular disease is governed by environment. The climate of Britain is notably varied, not only from year to year, but also from district to district and following the differences in rainfall and temperature so the problems of disease differ. It is in the interest of every farmer and smallholder to study the conditions around him. He should find interest in acquiring as much information as possible on the common diseases in his district, so that when control measures are applied they may be done with understanding and a feeling that time is being well spent.

Many principles of control have been discovered by past generations and have been embodied in the tradition of good husbandry. Perhaps chief among these is rotation of crops. Akin to rotation and serving a similar purpose is *hygiene*. For example, it is unwise to apply to a field any plant material capable of carrying a pathogen to which the coming crop is susceptible. Flax by-products (shives, etc.) often contain spores of Rust (*Melampsora lini*) which are capable of infecting flax or linseed and they should not be applied to soils on which either of these crops is to be grown. On the other hand, rust spores from wheat-straw or manure do not infect wheat.

As far as possible only seeds and planting material which is *disease-free* should be used. Insistence on this will stimulate the supply. Where certification schemes exist full advantage should be taken and an effort made to find out what certification implies.

The most *suitable crop plants and their varieties* should be selected. Examples of the risk in disregarding this precaution are legion. Failure to produce onion seed is almost a foregone conclusion in certain districts near the coast where Downy Mildew, which defies control, brings regular disaster. Golden Wonder, a potato of the best quality is so intolerant of virus diseases that it is uneconomic to grow in the South of England, even when relatively high prices can be obtained. If a crop or particular variety is not grown in an area, the newcomer would do well to inquire the reason before taking chances. In the same connexion it is well to keep a watch for new varieties which might with advantage replace existing ones. Those who are experimentally minded should find interest in growing small plots for themselves, but in any case they would do well to keep themselves informed of the results of any trials held locally by the National Agricultural Advisory Service or by County bodies.

Balanced manuring, besides giving the opportunity for maximum yield may increase the resistance of the plant to disease.

Finally there are certain *routine protective measures*, such as the application of sprays to combat Potato Blight and Apple Scab, which should on no account be omitted in some districts, even though the risk might be worth taking in others.

NUTRITIONAL DISORDERS

Correct feeding of a plant may at first thought seem a simple matter; or there may be surprise that feeding is necessary at all when it is considered that wild plants receive no nutrients additional to those supplied naturally. Correct feeding, however, cannot be undertaken on a standardized formula. There are big differences in the demands of the various crop plants and there are equally big differences in the amounts of food available on the various soil types and also in similar soil types under different climatic conditions. Comparison of cultivated with wild plants only emphasizes the need for feeding, for it is clear that wild plants are smaller and less productive than those of corresponding crop plants. Only indigenous species or varieties which suit the local environment are able to survive unaided by man. The cultivator's job is so often to grow delicate and man-bred plants under conditions where they could not survive unaided.

To deal fully with soils is not within the compass of the present section—those interested are referred to "Good Soil", see Volume III of the present work—but here the reader may be reminded that all soils are very complex in composition. Briefly, they are aggregates of small mineral particles together with organic matter, the latter having resulted from the decay of plant and animal remains. Most soils teem with living micro-organisms and small forms of animal life, which influence their fertility. The soil type is governed by the nature of the parent rock from which its mineral portion was derived and from the treatment to which it has been subjected by centuries of weathering. Great Britain has been called a museum of geological formations on account of the very large variety present in a relatively small area. This variety is primarily responsible for the large number of soil types present. Over the northern part of the country there are glacial deposits in many places and this provides great variety of soil-forming materials; continued action of rivers has complicated the picture in many parts of Great Britain by collecting material from the several formations in their courses and depositing parts of the mixture at lower points in the stream. In some areas it is not uncommon to have half a dozen or more different soil types formed within the boundaries of a single farm, with each type requiring a different treatment.

The quantity of any particular mineral element in the soil, depends on the kinds of rock from which its mineral particles were derived. If those elements necessary to plant life are present in satisfactory proportions and if they are in forms sufficiently soluble in soil water or are otherwise available to the plant then the favoured land is likely to be naturally fertile. But even with a fertile soil, intensive cropping soon uses up the reserves of available nutrients and seasonal releases, resulting from weathering, must be supplemented by the application of manures. In times of small populations, before so much was demanded of the land and when dung was more plentiful, the farmer could settle down to a comfortable rotation which included a rejuvenating fallow every few years. Nowadays the farmer must frequently change his cropping plans according to the dictates of unstable economic conditions and protean world politics. Such treatment is likely to alter the nutritional levels in the soil in directions not anticipated through past experience. These alterations may be adjusted by the skilful use of dung or other organic manures supplemented by artificial manures. Misuse is sure to lead to unbalanced feeding of the plant and this will become manifest on the plant itself by symptoms of deficiency or of excess.

The "mineral" elements demanded by the growing plant in greatest quantities are nitrogen (N), phosphorus (P) and potassium (K). Dung contains small quantities of all these together with other minerals and organic matter. Most "artificial" manures contain one or more of the minerals in a highly concentrated form. Other elements necessary to the plant include magnesium (Mg), sulphur (S), iron (Fe), manganese (Mn), boron (B), zinc (Zn) and copper (Cu). Excepting magnesium these are required in relatively minute quantities and for this reason are sometimes referred to as "trace" elements.

The science of diagnosing deficiencies is of recent origin and is only now emerging from the experimental stage. It is certainly not a pastime for the amateur. Quite often the same conditions which will bring about a deficiency of one element will also cause a short supply of another and the symptoms induced by one may modify those induced by some other. Then, too, some virus diseases produce symptoms which may easily be mistaken for those of a deficiency. Injury to root or stem may also confuse the picture. In spite of these difficulties, however, certain generalizations have been evolved. It is, for instance, of helpful significance that deficiencies of nitrogen, phosphorus, potassium, magnesium and manganese cause visible changes in the old leaves first and then successively affect the younger. The reverse is true of the leaf symptoms of nearly all virus diseases and for deficiencies of calcium, iron and boron.

Nitrogen.

Nitrogen, which is the most important single nutrient to be taken up by the roots, is used by the plant for protein building. When abundant, it typically encourages lush foliage of a dark green colour. A dearth of nitrogen in the soil results in a plant of restricted growth with small,

rather upright leaves, having a yellowish colour which may later become tinted with orange or red. Change in leaf colour usually begins with the old leaves and spreads to the younger. These symptoms may well be seen in members of the cabbage family (*Brassicae*). Apple and plum trees show not only tinted leaves but, in addition, leaf-fall tends to be premature and the bark becomes reddish brown in colour; the fruits of apple become highly flushed. Nitrogen is in greatest demand when foliage increase is at its maximum and it is therefore a common practice to apply in spring to cereals and to certain other crop plants, quick-acting nitrogenous manures such as sulphate of ammonia. If nitrogen is taken up by the plant in excess the tissues become soft and particularly susceptible to injury and disease.

Phosphorus.

One of the functions of phosphorus is to help the plant in its utilization of nitrogen. A deficiency induces colour changes in the leaf similar to those described for nitrogen. On plants of the cabbage family, on leaves of apple and of certain other types, there is a tendency for dull purple tints to precede the brighter red and orange changes. Leaf-fall is premature and this begins with the older leaves. Ample supplies of phosphorus are essential in seedling development and the addition of superphosphate of lime or some other form of phosphorus is an important part of seed compost.

Potassium.

There is still uncertainty as to the exact role of potassium within the plant, but it is known to be concerned with carbohydrate manufacture and is therefore of particular importance in the nutrition of crop plants such as potatoes, mangolds and sugar beet, which store quantities of sugar or starch. Visual symptoms of deficiencies include stunting and, when shortage is acute enough, the main shoots die back from the tips. Leaf colour tends to be a dull bluish-green. The best-known symptom of potash hunger is, however, marginal " scorch " of the leaf (Fig. 21). This is seen as a brown or greenish-brown zone round the margin; there may also be brown spots or patches between the veins with a tendency for them to be concentrated near the margins. Spotting, together with marginal " scorch," is characteristic of the leaves of affected potato and lucerne, while marginal " scorching " without spotting is to be seen on the leaves of broad bean and apple.

Magnesium.

Magnesium is a necessary component of the green colouring matter of foliage and is therefore essential to the manufacture of carbohydrate (photosynthesis). In addition, it probably has other functions. Balance between potassium and magnesium is important; soils treated with excessive quantities of potash may induce symptoms of magnesium deficiency. This is particularly so in glasshouses where large quantities of potash are often applied annually. As a rule, symptoms of deficiency are not seen until comparatively late in the life of the plant and there is little reduction of yield in those plants with an annual habit. Leaf symptoms differ a great deal with the type of plant, but a yellowing of the leaf tissues between the veins is common to many; in others, brilliant tints of orange, red or purple, in typical patterns, may result. Magnesium deficiency frequently occurs in glasshouse soils; tomato leaves react by producing a yellowing of the tissue between the veins,

Fig. 21. Potash Deficiency.
Gooseberry leaf with marginal " scorch ", the result of insufficient potash.

followed, in severe cases, by defoliation. Gooseberry leaves show broad red marginal bands in which red gradually fades to cream. In black currant, the leaf centres become purple while the margins remain green. With apples, the tissues of the leaves between the veins become " scorched " in appearance and the older leaves drop off prematurely, leaving a characteristic tuft of young leaves at the tip of an otherwise bare shoot.

Iron.

Iron is concerned with the formation of chlorophyll, but, though essential, only minute quantities of it are required by the plant. Where iron is not available, as in many chalky soils, yellowing of the foliage is to be expected and this

is first seen on the youngest leaves. In apple and cherry, the whole leaf blade becomes yellow excepting the veins, which remain green. In pear, the green of the veins may be absent; but the fruits of both apple and pear may assume an unusually red hue.

Manganese.

There is uncertainty in the function of manganese but if deficiency is severe enough, symptoms appear on the foliage and with peas and beans, in the seeds. Yellowing of the older leaves in patches, of characteristic pattern, is common and is seen in apple, pear and cherry. It occurs between the veins, beginning at the margins and progressing inwards. The oat produces easily recognized symptoms; in the young plant the part of the leaf blade near the stem develops grey or buff coloured streaks or spots. These coalesce

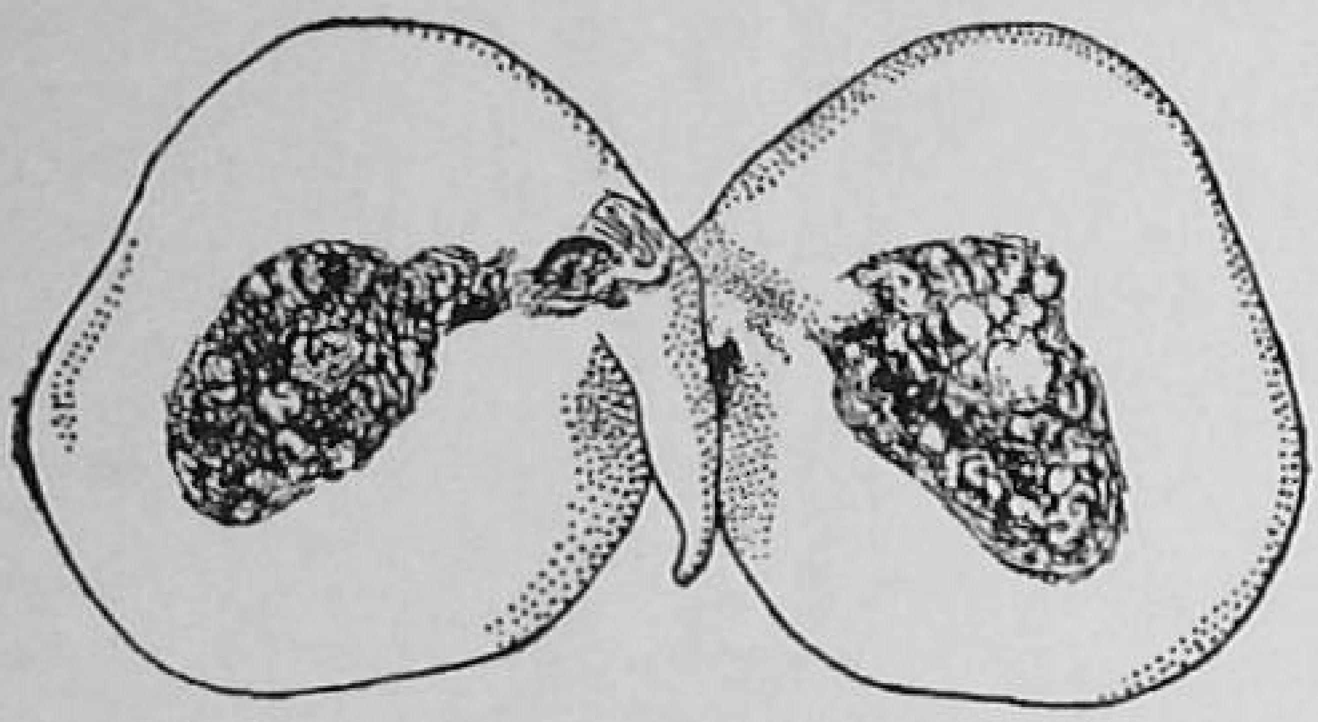

Fig. 22. Marsh Spot of Peas.

An affected pea seed which has been split open to expose the pocket of shrivelled and discoloured tissue at the centre. The disorder is associated with insufficient available manganese in the soil.

the tissue becomes brown and dead and the blade bends at the section affected, leaving the tip portion still green. In peas, and less commonly in broad and runner beans, pockets of brown, dead tissue develop at the centre of the seed and the plumule is also sometimes affected (Fig. 22). This condition, known as Marsh Spot, does not appear until the seed has begun to ripen. It is primarily a disease of the seed, but as a rule it does not impair germination and since dried peas are usually served at table unsplit, the trouble passes unnoticed. Seeds with Marsh Spot often develop from vigorous plants in which the foliage shows no symptoms.

Boron.

The effects of boron deficiency are various. With sugar beet and mangolds the young leaves in the centre of the rosette die (Heart Rot) and small distorted leaves struggle to develop in their place; the oldest leaves become flaccid and have a " scorched " appearance. With swedes, the flesh at the centre of the root becomes watersoaked and brown (Brown Heart or " Raan ") (Fig. 23). With celery, the leaves show a brown mottling, the stems become brittle and the stalks rough to the touch on account of the development of numerous small cracks.

Calcium.

Calcium has a special position in relation to plant nutrition. Its presence is an important factor in controlling the acid-alkaline balance of the soil but in addition to this it contributes to the rigidity of the cell walls by the deposition of a salt, calcium pectate. It also enters into other life processes. On some soils absence of calcium will produce well-defined symptoms on members of the cabbage family in which a narrow white zone appears around the leaf margin of young plants. On older plants the colour is brown and the margin tends to become ragged. In the apple, leaves at the tips of twigs are very small and these may die, to be followed by death of the tips of the shoots themselves. Other leaves of the tree show marginal " scorch " with edges which are ragged and curled sharply towards the upper surfaces.

Distribution of Deficiencies.

Some of the conditions under which deficiencies occur are now well known and are clearly associated with soil type and district. Deficiencies may also result from malpractices such as the common one of over-liming the soil. Potash is more likely to be deficient on sandy soils than on those of clay texture. Deficiency of manganese, iron and boron is frequently associated with alkalinity, while phosphorus deficiency can occur on both acid and on alkaline soils. The amounts of phosphorus made available each year depend to some extent on the amount of rainfall.

The occurrence of a deficiency symptom in a plant does not necessarily indicate a shortage of the element in the soil, but rather that the element is not present in a form which can be taken up by the plant. Some of the soils of Romney Marsh in Kent, for instance, have a very high content of manganese which is nearly insoluble in the highly alkaline soil water. Iron is similarly " locked up " in many of the chalk soils.

Confirmation of Visual Symptoms.

It might be supposed that chemical analysis of the soil would reveal whether the sample examined were deficient or not, but as has already been pointed out, the presence of an element is not an indication of its availability to the plant. In recent years, several chemical method have been devised for assessing the amounts available to the plant of the major nutrients, potash, phosphorus and calcium. Such methods attempt to reproduce soil conditions in the laboratory and have achieved a measure of

success. With those elements of which only minute quantities are present for detection, however, this is less feasible, for it must be remembered that the chemical and biologic reactions going on in the soil are very complex and it may be impossible to imitate them with sufficient accuracy. Symptoms seen on the foliage and on other parts of the plant are useful guides to deficiencies, but confirmation by more positive means is usually desirable. Such confirmation may be obtained by assessing the amounts of various elements in the tissues or by injecting or spraying a few plants with a compound containing the element to see whether a response is made.

Controlling Deficiencies.

The normal practice of applying fertilizers to the soil is, of course, to forestall deficiencies. If the mixtures are not well proportioned for the particular circumstances, then one, or other deficiency may show up. Thus, as previously remarked, most mixtures of artificial fertilizers contain nitrogen, phosphorus and potash. If nitrogen is in excess there will be relative deficiencies of the other two nutrients though symptoms of potash deficiency are the more likely to appear. This may best be corrected by a separate addition to the soil of potash alone or by adjustments in the proportions of the next mixture to be applied. Similarly, the soil may be limed to counter acidity and to supply calcium; if liming be overdone, manganese deficiency sometimes results. To maintain a suitable level of each nutrient the period of action of each preparation must be taken into account. Thus, superphosphate is a quick-acting form of phosphorus while bone meal is much slower, but continues to supply small quantities of phosphates over a much longer period. Inorganic nitrogenous manures such as nitrate of soda and sulphate of ammonia are soon leached from the soil while many organic forms such as dung or shoddy act more slowly.

With trace elements, the problem of making good a deficiency is not always so easy to solve. Thus, on certain alkaline soils, the very property of the soil which has made natural manganese unavailable ensures the rapid "locking up" of any soluble manganese which might be added in an attempt to make it good. On the other hand small but sufficient quantities of the element can rapidly be absorbed through the foliage and treatment of a crop by a spray application is often practicable. Marsh Spots of peas, for example, has been avoided by spraying the plants at blossom time with a solution of manganese sulphate. The spray method also lends itself to controlling deficiencies of manganese and magnesium in tomatoes in glass-houses although on certain soils Epsom salts (magnesium sulphate) applied directly are taken up satisfactorily by the plant.

Iron deficiency of fruit trees is not uncommon in the chalk districts of Kent and because of this association the yellowing of the foliage has been referred to as "lime-induced chlorosis." Application of iron salts to the soil has proved unsatisfactory because the iron is rapidly converted to an insoluble and therefore unavailable form. A more successful treatment is to introduce into the trunk of the tree a dose of iron (ferrous) sulphate. This is done by first drilling one or more holes (according to the size of the tree) with a brace and bit and then inserting tablets of the compound by means of a special "gun." It is important to carry out the operation according to a precise method or much damage may be done. Thus from a dosage table it is

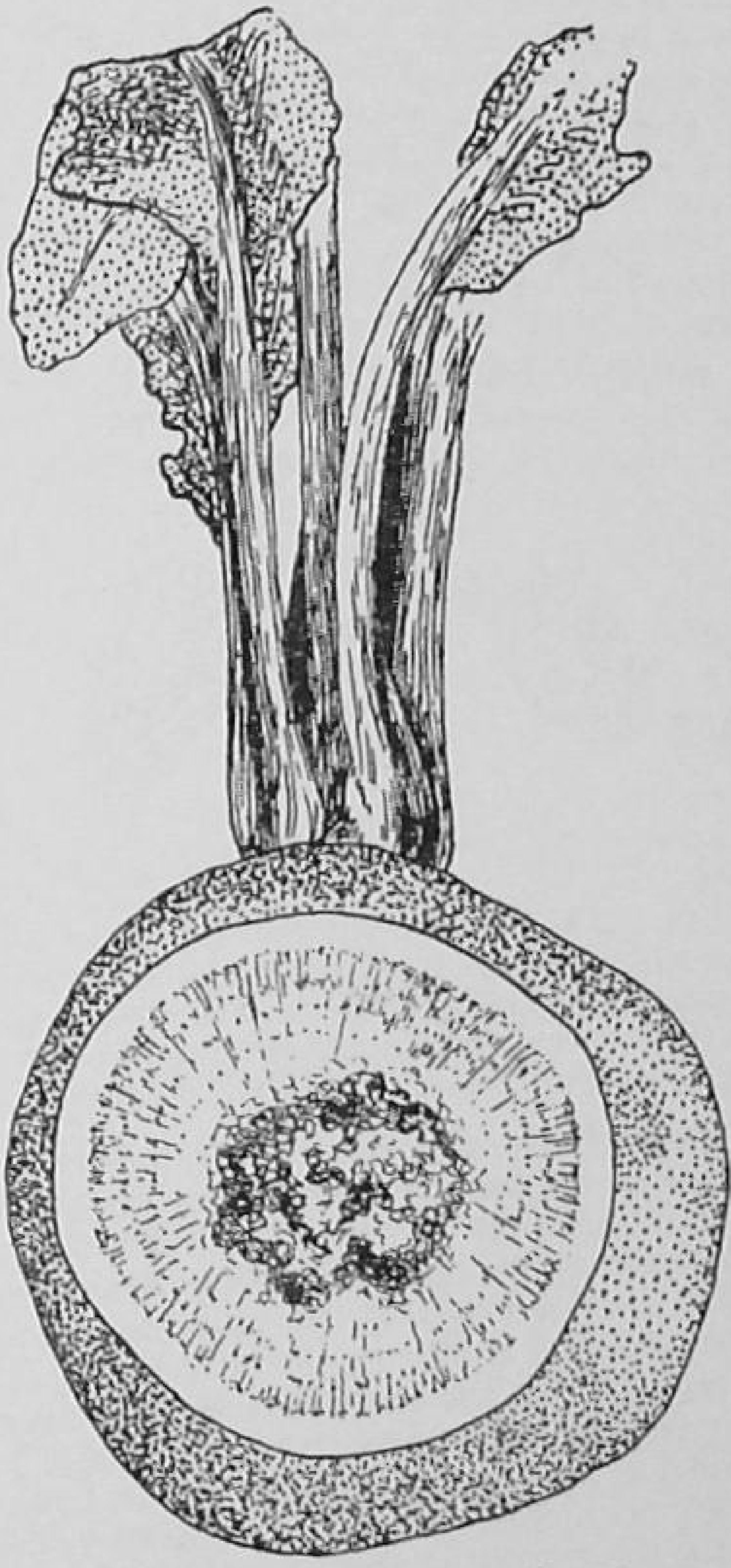

Fig. 23. Brown Heart of Swede.
Cut surface of swede showing mottled brown zone of flesh.

given that a tree with a circumference of 7 in. should be drilled with one hole to a depth of 1 in. and that one tablet containing one gm. of ferrous sulphate should be inserted. A tree with a circumference of 28 in. on the other hand requires nine holes each 2½ in. deep, and two tablets are inserted into each hole. The gun is loaded with a cork which follows the tablet into the tree and so plugs the hole.

Another deficiency which is commonly associated with alkaline soils is that of boron. In practice, however, sufficient of the element is taken up by the plant when a dressing of borax is applied to the soil. The usual rate of application is 20 lb. to the acre.

Damage by Excess.

Although deficiencies are the more common problem, excesses of nutrients and of non-essential substances may also be troublesome. Thus, red currant bushes are particularly sensitive to injury by "chloride" in the soil and this frequently results from applying potassium in the form of potassium chloride—better known as "muriate of potash." The main symptom is marginal leaf scorch very similar to the effect caused by potash deficiency and this has prompted the unwary to apply yet more of the offending salt.

There is good evidence that injury to the tissues of roots can result from the accumulation of salts following repeated heavy doses of "chemical fertilizers" to soils. This is particularly likely to occur in glasshouses in which valuable crops justify considerable expenditure on manures. It is often forgotten that, however prolific yields may be, there is a limit to the amount of nutrients which can be absorbed each year and that repeated dressings may, after a time, convert the soil water into a saline solution which is sufficiently concentrated to injure the roots.

CONCLUSION

Is Disease on the Increase?

"Why is there more disease to-day than when I started farming?" This is a common question asked by many farmers of middle age.

The belief that diseases are more numerous and widespread is difficult to challenge because, except for sensational epidemics, careful annual records are of comparatively recent origin and even now the statistics are far from complete. Fifty years ago relatively little was known about the nature of plant diseases and such information as existed was in the hands of those who were interested only in the more academic aspects. Now, for some thirty years, there has been in existence a national organization which has concerned itself with the welfare of crops and a large body of information has been assembled.

Following these investigations into diseases, farmers have for the first time been made aware of their importance as the cause of crop failures; attention has been drawn to symptoms, control measures have been adopted. All this has made the grower "disease conscious," and has doubtless helped to give an impression of increase in diseases. Nevertheless, taking into account the greater emphasis and the fact that proof may be wanting, there is reason to believe that the farmer, and still more the nurseryman, has to contend with more disease than did his father. Nor is this surprising in face of the ever increasing demands from the soil and from the plant. Cropping is more intensive and fallows are less frequent than half a century ago, thus making hygiene more difficult to practice. There has been an ever growing demand to maintain "purity" in variety or strain of plant so that every individual in a crop is constitutionally similar to the others. This racial purity, particularly when brought about by vegetative propagation (forming clones) favours epidemics, rather than limited infections such as might be expected where differences exist between individuals.

Not a few diseases have been introduced from abroad, and the rapidity of modern transport has aided the operation by keeping the pathogen fresh in transit. Potato Blight, Downy Mildew of the hop and Bacterial Canker of tomato are three introductions selected at random. There is a risk that others, including Bacterial Ring Rot of potato (*Corynebacterium sepedonicum*) and Fire Blight of pears (*Bacillus amylovorus*), may be imported.

Restricted international trade and war conditions has led to the cultivation of certain plants near their climatic limit and so has introduced to Britain types which are particularly susceptible to disease. Outdoor cucumbers and tomatoes are familiar examples.

The plant pathologist is often regarded very much as a doctor is in relation to human diseases and in many ways he serves a similar function. He is at a singular disadvantage, however, in that plants less frequently than the human patient, have the ability to recover. They are rarely, if ever, cured of infection by viruses and by certain other pathogens which become systemic.

Successes of the Past.

It is not surprising therefore that the farmer is at times disappointed when he is told that he can do very little to help an afflicted crop, but must concentrate his efforts on preventing a recurrence of the disorder in the next. He may even feel that the science of plant pathology has been of little value in the past. But a glance back at what has already been done will show that considerable progress has been made. Many of the routine control practices now generally adopted have proved so effective that the threat of a return of the disease in question has been removed; their very success has effaced the memory of the disasters of the past and of the research and labour which has been expended upon their perfection. Thus, no longer is a potato famine expected to result from Blight, nor does infestation by the long-lived Wart Disease fungus render ground unfit for potato production. "Degeneration" of potatoes and strawberries has been brought under control; the careful fruitgrower knows how to produce apples and pears which are Scab free. Further, it is remarkable that in recent years an increasing number of growers have evinced a vivid appreciation of deficiencies in plants and apply not only the common fertilizers but also small doses of boron, manganese and iron to bring the tints of their leaves back to normal or to prevent rots and stunted growth which may result from unbalanced nutrients.

These control measures which have gradually been absorbed into normal cultural practice, are largely the result of investigational work which has been carried out by the very small body of biologists and chemists who have made it their business to attend to plant health.

Proud as we are of the progress achieved, we may well wonder whether men like gods in a Wellsian Utopia will ever regard the present efforts of science to control plant diseases with good-natured disdain. Might there not be a few simple principles to be discovered which would solve our difficulties? Unless they are found we must continue to accept the present position in which the solution of one problem seems to be the herald of another; possibly a result of disturbing the "biologic balance" or of encouraging the cultivator to overstep once more the ever widening margins of safety in his quests for greater yields and more variety.

Looking ahead, it seems that yet more emphasis will be given to indirect methods of plant-disease

control and programmes for this will have to embody long-term planning. During the present century, state-sponsored schemes of prohibitions and inspections have done a great deal to meet the periodical crises which have been brought about by epidemics of one disease or another; but these schemes, however effective, demand the expenditure of much time and energy by trained personnel and add to the expense of raising produce.

The spread of virus diseases in pure stocks, especially when propagation is by vegetative means, has already been discussed and it has been shown, for instance, that stocks of potatoes, strawberries and raspberries have suffered "degeneration" diseases. From consideration of the menace of "purity" it has been suggested that if individual plants in a plantation had slight constitutional (genetical) differences, they would be more resistant to mass attack by pathogens. Controlled "hybridization" could be brought about by periodically raising new stocks from seed; for this purpose it would be necessary to employ breeding stations which would select and maintain suitable parents for seed production.

New power has already been given to the plant breeder by the discovery of fresh species and varieties of plants. To this end expeditions have recently visited South America to collect from their continent of origin the many different forms related to the potato. It is hoped to obtain by "crossing" these wild types, progeny which is immune to the more serious diseases which attack those now cultivated; and at the same time to embody the many other qualities which are demanded by the cultivator and consumer.

Finally, help may be expected from the study of the relation between a plant and its environment. Data are now being accumulated of the meteorological conditions (such as temperature and humidity), which surround the individual plant and this investigation of "microclimate" is typical of the new approach.

When Advice is Wanted.

The diagnoses and treatment of human and animal ills is generally admited to be most safely delegated to those who have achieved skill from a rigorous course of training. With sick plants the sentimental and legal aspects are more frequently absent and there is a greater tendency for the grower to chance his own diagnosis and treatment. Those who grow plants on a commercial scale may obtain free specialist advice from within the recently formed National Agricultural Advisory Service and a request to the County Agricultural Officer or to the local District Advisory Officer should bring the aid which is required. Gardeners and allotment holders should apply to the County Horticultural Instructor who usually has his office at the County Hall.

Literature on Plant Pathology.

The specialist in plant pathology obtains his up-to-date information from many sources, chief of which are the technical articles and reports from workers at research stations in Great Britain and abroad. The number of workers engaged in the practice of plant medicine is very small compared with those employed in human medicine and as there are correspondingly few facilities for their training, the range of text-books on the subject is small. The science is young and has so far been developed mainly by the professional mycologist. Articles which can be appreciated by the layman are difficult to construct because of the unfamiliar background of plant-life which must first be understood by the reader. There are, however, certain books and articles to which the non-professional reader who wishes to extend his knowledge is referred. The history of the study of fungus diseases has been interestingly presented by Large (1940). Kenneth Smith (1940, 1943 and 1945) has given popular accounts of viruses and of the diseases they induce. Descriptions of certain diseases of British crop plants and recommendations for their control are given in the various bulletins and leaflets which are prepared by the Ministry of Agriculture. These are frequently being revised and supplemented. New information is also given from time to time in *Agriculture*, the Ministry's Journal which is issued at monthly intervals.

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